

Evaluation of NRC Aquatic and Crop Resource Development

Final Evaluation Report

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ACRONYMS AND ABBREVIATIONS

AAFC	Agriculture and Agri-Food Canada
ACC	Algal Carbon Conversion
ACOA	Atlantic Canada Opportunities Agency
ACRD	Aquatic and Crop Resource Development
AIF	Atlantic Innovation Fund
ASPM	Administrative Services and Property Management
BIWG	Bioeconomy Interdepartmental Working Group
BMS	Business Management Support
BPS	Business and Professional Services
BSC	Bio-based Specialty Chemicals
CB	Communications Branch
COSIA	Canada's Oil Sands Innovation Alliance
CRL	Client Relationship Leader
CWA	Canadian Wheat Alliance
CWI	Canadian Wheat Improvement
EAC	Evaluation Advisory Committee
FB	Finance Branch
FTE	Full-time equivalent
GM	General Manager
GRDI	Genomics Research and Development Initiative
HRB	Human Resources Branch
IBFP	Industrial Biomaterials Flagship Program
IP	Intellectual Property
IRAP	Industrial Research Assistance Program
ITSS	Information Technology and Security Services
KM	Knowledge Management
NCI	Nature's Crops International
NHP	Natural Health Products
NRC	National Research Council
OAE	Office of Audit and Evaluation
MNE	Multinational enterprise
NMR	Nuclear magnetic resonance
NS	Nova Scotia
PEI	Prince Edward Island
PMO	Project management office
PRS	Planning and Reporting Services
R&D	Research and development
RTO	Research and technology organization
SEC	Senior Executive Committee
SLA	Service level agreement
SME	Small and medium-sized enterprise
SSC	Shared Services Canada
TEA	Techno-economic assessment
TRL	Technology readiness level
US	United States

EXECUTIVE SUMMARY

This report presents the results of the 2015-16 evaluation of the National Research Council (NRC) Aquatic and Crop Resource Development (ACRD) Portfolio. ACRD provides technical services, technology development support and credible scientific advice to help Canadian technology-based companies transform Canada's bio-based resources into sustainable, high-value products. At the time of the evaluation, ACRD hosted four NRC programs: Canadian Wheat Improvement (CWI) Flagship; Algal Carbon Conversion (ACC) Flagship; Bio-Based Specialty Chemicals (BSC); and Natural Health Products (NHP). The NHP Program was terminated in the Fall 2015.

This evaluation assessed the value-for-money of the ACRD Portfolio, including relevance, performance, and resource utilization. It focused on the three-year period since the Portfolio was created (2012-13 to 2014-15). Recent developments that have occurred since April 2015 were also taken into account, as appropriate and possible.

The key findings for each evaluation issue have been summarized and are presented below, along with the recommendations and management responses.

Key Findings: Relevance

Need for ACRD's Research and Development (R&D) Capabilities:

- There is a clear and demonstrable need for the R&D capabilities offered by ACRD. Through the use of these capabilities, ACRD seeks to contribute to the strength and development of the Canadian bioeconomy, which has the potential to generate significant benefits to Canada.
- Experts and external stakeholders were generally supportive of ACRD's areas of focus (i.e., hosted programs). The NHP program showed less potential than expected for broader sector impacts and never reached its intended scale. This led to the decision to terminate the program in the fall of 2015.
- Moving forward, ACRD is proposing an increased focus on the food and consumer packaged goods sector. The rationale for this revolves around the size of the industry sector as well as clearly identified opportunities for impact in this sector. This area of focus was also supported by some key external interviewees and experts consulted as part of the evaluation.
- ACRD capabilities generally respond to the R&D needs of industry clients and other stakeholders. While the majority of ACRD's capabilities are aligned with approved programs, there are capabilities that have significant activity outside of approved programs (e.g., crop development technology platforms) and are of value to clients. The development of a food program could help to better leverage these capabilities and would also allow for investments to be made in order to maintain and further develop these capabilities.
- ACRD activities complement those offered by other organizations and facilities.

Alignment with NRC and Federal Priorities:

- ACRD's industry focus aligns well with the NRC strategy and contributes to the achievement of NRC's first strategic outcome, that is, "Canadian businesses prosper from innovative technologies".
- Given that innovative uses for biomass are being applied in a variety of areas, ACRD activities contribute to addressing at least three of NRC's critical issues: economic

development; pressures on natural resources; and, climate change and the environment. The 2014 federal Science and Technology Strategy also identifies Environment and Agriculture as priority areas for research.

Alignment with Federal Roles and Responsibilities:

- ACRD's activities and outcomes are in line with the mandate of NRC, as stated in the NRC Act. External stakeholders were also supportive of the role NRC plays conducting R&D in support of the Canadian bioeconomy.

Key Findings: Performance

Transition to an RTO-Ready Portfolio:

- ACRD's transition to a research and technology organization (RTO) portfolio has taken longer than that of other NRC portfolios. Some of the factors that have hindered ACRD's transition to an RTO-ready portfolio include: the extent of the change it underwent as a result of the transformation (more than other portfolios); the fact that its hosted programs were established at different times, with different expectations, previously different reporting structures, and different program management models; and, not having some key positions staffed.
- Good progress has been achieved in terms of the portfolio's strategic focus, attention to health and safety, and increased client focus by staff.
- Matrix management has enabled greater collaboration among ACRD's various sites. However, the roles and responsibilities of the portfolio versus those of NRC programs (for example, relating to accountability for project delivery) are not well understood within ACRD. Interactions and processes for the allocation of resources to projects vary between programs and depend on the individuals involved.

Recommendation 1: *ACRD should develop and communicate overall principles for how matrix management will work within the portfolio. This should include assigning primary roles and responsibilities and providing guidelines for program / portfolio interactions. Moving forward, ACRD should provide regular communications relating to matrix management, encouraging sharing of best practices, and follow up regularly to assess the effectiveness of program-portfolio interactions.*

Management Response and Proposed Actions: Accepted. ACRD is adopting a balanced program-portfolio matrix model. ACRD will deliver a document to staff, clearly defining program-portfolio interactions and outlining key program and portfolio roles and responsibilities. Training will follow and mentoring will be provided via the project management office (PMO). ACRD will enhance communication to all staff via Portfolio-wide Town Halls and Program team-Team Lead meetings, where best practices will be communicated. ACRD will conduct quarterly reviews of programs to ensure effective program delivery. ACRD will continue its monthly pipeline review meetings, as well as biweekly meetings between Program Leads (program-based) and ACRD management (portfolio-based).

- Current business practices in place at ACRD (specifically those related to project approvals and resource allocation) are bureaucratic, overly complicated and unnecessarily different between programs. Within a program, the processes and approval requirements for all projects are the same, regardless of project size or risk level – this was noted as being a

source of frustration for some clients. ACRD management is aware of these issues and efforts are currently underway to harmonize (where appropriate) and simplify processes across ACRD's hosted programs.

Recommendation 2: *ACRD should continue current efforts to review processes surrounding the approval of projects and allocation of resources, with an aim of harmonizing and simplifying them. As part of these efforts, ACRD should adapt the level of approvals required, depending on risk, project size and maturity of program. Following this review, simplified processes should be effectively implemented and validated.*

Management Response and Proposed Actions: Accepted. A preliminary review and recommendations on Project Agreement Development (including project selection and resource allocation) and associated project management processes were presented and approved by ACRD Management in late 2015-16. A Project Management Working Group under ACRD's PMO will complete and rollout the processes, including approval and resource allocation, over the full project management life cycle for both internal and external projects. BMS and the ACRD PMO are working to further simplify and streamline processes for low value, low risk projects. An analysis to support this review has been completed. ACRD harmonization efforts will be aligned with NRC-wide initiatives where applicable.

- Most ACRD staff understand the value of project management and recognize that it is a required practice at NRC. However, many lack the skills and access to the resources that would allow them to manage projects effectively.

Recommendation 3: *Project Leads, Team Leads and other appropriate staff should be sent on project management training as soon as it is available. If it is not expected to be available through NRC in a timely manner, outside sources of training should be considered. The role of the centralized PMO should be re-evaluated; roles may differ based on project size and project management skills of the Project Lead. ACRD should also consider whether there is a role for dedicated or more experienced project managers to provide coaching and support to new project managers.*

Management Response and Proposed Actions: Accepted. ACRD staff will receive project management training through an external service provider. Externally provided training will be followed by PMO-led coaching / training sessions to Project Leads and Team Leads. Experienced project managers will be available to support Project Leads who do not have strong project management skills and to help manage large / complex projects. A Project Management Forum has been established whereby the Project Managers meet weekly to provide a venue for support to new project managers and share best practices.

Appropriateness and Allocation of ACRD Resources:

- For the most part, ACRD has the appropriate technical / scientific competencies and equipment in place to meet current program needs. The two flagship programs appear to be particularly well resourced.
- The demand and utilization of resources by programs is very uneven across ACRD's five geographic sites. At some sites, utilization for 2014-15 was 30% or less. Further capacity development by underutilized staff, in particular, could help ACRD minimize risks related to limited depth of expertise in specific areas.

- Internal and external interviewees also noted the importance of continued strategic investments in ACRD competencies to ensure that these remain leading edge and are able to meet future program and client needs.

Progress toward the Achievement of Expected Outcomes:

- Following lower than expected revenues in 2014-15, ACRD has exceeded its revenue target for 2015-16 by 35%.
- The majority of clients are very satisfied with the services they have accessed from ACRD. Client criticisms primarily centered on the administrative aspects of the interaction.
- The two flagship programs, CWI and ACC, are progressing well against program plans and are well-positioned to achieve expected outcomes. Early program milestones for the BSC program have also been met and the program exceeded its revenue target for 2015-16. BSC experts felt that the program design is likely to lead to the achievement of expected outcomes.
- ACRD has conducted effective outreach efforts and increased awareness of the Portfolio. Some specific improvements were identified for future outreach efforts, including: further promoting the specific services available (e.g., on the NRC website), as well as the benefits of working with NRC; and, alleviating client concerns around continuity of services by providing more information about NRC's transformation and future direction.
- The roles of ACRD and NRC Business Management Support (BMS) around client engagement and account management are not well defined and are inconsistent between programs. Concerns were raised about the efficacy of researchers playing significant business development roles instead of delivering on opportunities generated by Client Relationship Leaders (CRLs).

Recommendation 4: *In collaboration with BMS, ACRD should clarify and communicate how the two can work effectively together to achieve client outreach and engagement objectives. BMS support and mentorship should also be provided to researchers who are interested and effective in engaging with industry, to enable them to do so. Finally, ACRD should clarify which client engagement roles are most effectively done by BMS staff and which are done most effectively by researchers.*

Management Response and Proposed Actions: Accepted. An account management guide – which clearly outlines roles and responsibilities of Portfolio staff and BMS personnel – has been prepared and discussed at a Town Hall meeting. BMS has used this as a basis for a corporate guide on Account Management. Roll out communication is being planned with the Program Leader Community of Practice. As part of the business and project management process, ACRD and BMS will identify clearly where the roles, responsibilities and authorities of BMS versus ACRD reside. This will be integrated in the ACRD project management and matrix management approach. ACRD will identify appropriate account managers that will work with and be mentored by the CRLs. A plan will be prepared in consultation with BMS.

Early Impacts:

- Most clients and collaborators felt that their projects with ACRD have been successful in achieving the project's desired outcomes and many referred to ACRD's contribution as both outstanding and crucial to the project.
- Many clients reported that it was still too early to have achieved socio-economic impacts as a

result of their NRC project. In cases where clients were able to identify impacts, these were mostly early or immediate impacts, including the advancement of technology readiness, accelerated path to market, and increased company spending on R&D.

Operational Efficiency:

- The efficiency of ACRD operations could be improved. Corporate key performance indicators show a decline in portfolio efficiency in recent years, and internal efficiency issues have affected client services in some cases.
- Efficiency issues are due, in part, to factors that are internal to ACRD (e.g., client focus of staff and ineffective business practices). Other factors that are affecting the operational efficiency of the portfolio include reduced support from NRC corporate branches and increasing non-project activities, both of which limit the available time researchers and technical staff have to undertake project work.
- ACRD has had significant service issues with some NRC common services. ACRD has multiple sites across the country and interacts with close to 90 common service liaisons across these sites. The level of service offered by NRC common services varies considerably from site to site and appears to be dependent on the customer service inclination and willingness of particular individuals. Issues with common services have contributed to inefficiencies and have had a negative impact on portfolio operations.

Recommendation 5: *NRC Senior Management should ensure that all corporate / common services have appropriate service standards in place, as well as a mechanism to escalate cases where client service and responsiveness are inadequate.*

Management Response and Proposed Actions: Accepted. Responses to this recommendation have been provided by the three Vice-Presidents responsible for corporate branches.

Corporate Services division has committed to: 1) The creation of the Client Service Centre (CSC), a new branch within the Corporate Services division, led by a Director identified as first point of contact for client relationship management and escalation of issues; 2) Onboarding of all services within the Corporate Services division to the service delivery management system by June 2016; 3) A minimum of one service page per branch, describing services offered and associated service standards, as well as instructions on how to request the services available, on MyZone; and 4) Townhall presentations and in-person discussions with all Corporate Services employees on the role of the new CSC, as well as the importance of client-focused service delivery.

Human Resources Branch will establish and share service standards in the areas of occupational safety and health, hiring, classification and client services. As part of the service standards, escalation mechanisms will be articulated.

Business and Professional Services (BPS) division has developed a draft Service Level Agreement (SLA). This SLA includes service standards for each BPS Branch and outlines the annual review process and the dispute resolution process. The Vice-President (VP) BPS will review the SLA with R&D VPs to ensure that there is mutual agreement on services and standards.

1. INTRODUCTION

This report presents the results of the 2015-16 evaluation of the National Research Council (NRC) Aquatic and Crop Resource Development (ACRD) Portfolio. ACRD helps Canadian companies transform Canada's bio-based resources into sustainable, high value products. The portfolio's technologies can be applied to a broad array of application areas, including bio-based industrial products, bio-energy, bio-based chemical manufacturing, and bio-based solutions for input into consumer products.

Following the evaluation overview presented below, Section 2 of this report provides a profile of ACRD. Sections 3 and 4 present the evaluation study's findings organized by broad evaluation question (relevance and performance) along with associated recommendations. Section 5 presents a brief conclusion drawn from the evaluation, while Section 6 lays out the management response to these recommendations and the actions that will be taken as a result.

1.1 Evaluation Overview

This evaluation assessed the value-for-money of ACRD, including both relevance and performance to date. It focused on the three-year period since the Portfolio was created (2012-13 to 2014-15). Recent developments that have occurred since April 2015 (e.g., approval of the fourth ACRD-hosted program) were also taken into account, as appropriate and possible.

Evaluations at NRC are conducted at the portfolio level. The relevance and performance of the four ACRD-hosted programs were examined insofar as portfolio outcomes are achieved as a result of program activities. The portfolio-hosted programs will undergo a more in-depth assessment at a later date as part of planned mid-term program reviews. It is expected that information drawn from this evaluation will contribute to these reviews.

This evaluation was led by an independent evaluation team from the NRC Office of Audit and Evaluation (OAE). The work of the evaluation team was supported by an Evaluation Advisory Committee (EAC), which provided advice related to the evaluation framework, approach, interpretation of findings and recommendations. The EAC, which included individuals from inside and outside NRC, did not act in a decision-making capacity, but rather played an advisory role in ensuring a high-quality and useful evaluation product.

1.1.1 Evaluation Rationale

ACRD was selected for evaluation based on consultations with NRC Senior Management and the work was carried out in accordance with NRC's approved evaluation plan. The Portfolio had not previously been the subject of an evaluation since it was launched in 2012. The timing of this evaluation also coincides with the horizontal evaluation of the Genomics Research and Development Initiative (GRDI). This is appropriate given that a large proportion of GRDI funding received by NRC goes toward supporting the Canadian Wheat Improvement (CWI) flagship program, which was recently rolled into the ACRD reporting structure.

There was also some efficiency gained by evaluating ACRD at this time as the CWI flagship program is scheduled for a three-year review in 2016. The broader Canadian Wheat Alliance, which represents a large portion of CWI's activities, was also the subject of a mid-term review in 2015. Each of these reviews is intended to draw upon one another.

1.1.2 Evaluation Design and Methodology

The evaluation questions, outlined at the start of each section, are based on consultations with portfolio management and a review of key documents during the planning stage. The evaluation design meets management needs as well as the requirements of the 2009 Treasury Board *Policy on Evaluation*. It also takes into consideration prior and other ongoing reviews, and places a greater emphasis and level of effort on aspects of the Portfolio that were not examined in detail as part of these reviews.

The evaluation methodology includes multiple lines of evidence and complementary research methods as a means to enhance the reliability and validity of the information and data collected. The specific methods used in the study included:

- Internal and external document review
- Administrative and performance data review
- Semi-structured interviews
 - 25 internal interviews (including ACRD management and staff, as well as staff from other related NRC portfolios, NRC Industrial Research Assistance Program and NRC Business Management Support)
 - 24 external interviews (including client and potential client organizations, program and initiative partners, and other Canadian industry stakeholders)
- Expert consultations
 - For two of ACRD's hosted programs (Algal Carbon Conversion and Bio-Based Specialty Chemicals), experts were asked to comment on the programs' design and likelihood of achieving desired outcomes.

For interviews, the following scale is used in the text of the report to indicate the relative weight of the responses for each of the respondent groups.

Table 1: Scale used when reporting on views and opinions of respondents

All / almost all	90% or more
Many / most	At least 50% but less than 90%
Some / several	At least 25% but less than 50%
A few	At least two respondents but less than 25%

A more detailed description of the study methodology, limitations and challenges is provided in **Appendix B: Methodology**.

2. PROFILE OF ACRD

NRC ACRD was established in April 2012, consolidating previously fragmented NRC expertise and building critical mass in bio-based resource development. The mission of ACRD is to provide technical services, technology development support and credible scientific advice to help Canadian technology-based companies transform Canada's bio-based resources into sustainable, high-value products. Its vision is to make Canada a world leader in the sustainable transformation of bio-based resources into economic value. The core marketable research and development (R&D) assets of the ACRD portfolio reside in the areas of:

- Valorizing raw aquatic and terrestrial biomass;
- Valorizing waste streams from resource production or exploitation;
- Identifying and characterizing active / functional ingredients in biomass for product development;
- Identifying improvements to aquatic and terrestrial biomass cultivation technologies; and
- Crop development through genomics and biotechnology.

A full logic model, developed as part of evaluation planning, details the activities, outputs and intended outcomes of the ACRD Portfolio (**Appendix A: ACRD Logic Model**).

2.1 Support to NRC Programs

At NRC, portfolios are the business units responsible for managing people and facilities. These resources are then deployed to various programs that have been approved by NRC's Senior Executive Committee (SEC). Currently, the large majority of ACRD resources are supporting ACRD-hosted programs. At the time of the evaluation, ACRD hosted four NRC programs:

- **Canadian Wheat Improvement (CWI) Flagship:** The goal of this program is to improve the yield, sustainability, and profitability of Canadian wheat for the benefit of Canadian farmers and the economy. The CWI Flagship program represents NRC's contribution to the Canadian Wheat Alliance, a collaboration between NRC, Agriculture and Agri-Food Canada (AAFC), the University of Saskatchewan and the Government of Saskatchewan.
- **Algal Carbon Conversion (ACC) Flagship:** The ACC Flagship program seeks to provide Canadian industry with a cost-competitive, value-generating solution to divert CO₂ emissions into algal biomass, which can then be processed into biofuels and other marketable products. This program involves Canadian commercial stakeholders ranging from large final emitters to small companies providing dedicated solutions throughout the value chain.
- **Natural Health Products (NHP):** The goal of this program was to accelerate the development of functional ingredients from Canadian bio-based resources that are used in natural health products, as well as to leave a legacy of methodologies and enabling technologies to increase the quality, safety and efficacy of natural health products in Canada. This program was terminated in the fall of 2015.
- **Bio-Based Specialty Chemicals (BSC):** This program will work with Canadian firms to accelerate and enhance the development of specialty and fine bio-based chemicals for differentiated consumer end markets and targeted industrial applications.

ACRD's four hosted programs were established at different times, with previously different reporting structures. Prior to January 2015, the two flagship programs, CWI and ACC, reported directly to the Vice-President, Life Sciences, before they were eventually rolled into the ACRD reporting structure. Also, while the first three programs have been operating since early 2013-14, the Bio-Based Specialty Chemicals program was only recently launched (April 2015).

It is also important to note that the termination of the NHP program was announced during the course of the evaluation. For that reason, the NHP program was not included as part of the expert consultations and is not discussed in the forward-looking evaluation questions.

2.2 ACRD Organizational Structure

The General Manager (GM) of ACRD reports to the Vice-President, Life Sciences, and has overall managerial accountability for the Portfolio. The GM is supported by three regional Directors of R&D and by a Director of Operations.

ACRD staff are grouped into site- and capability-based resource teams. Each team is headed by a Team Lead, responsible for managing the human resources within their team. The Team Leads report directly to one of the Directors. In accordance with the NRC operating model, staff are deployed in a matrix manner to ACRD's four hosted programs and to programs hosted by other NRC portfolios.

2.3 Portfolio Resources

2.3.1 Human Resources

As of July 2015, ACRD had a staff complement of approximately 230 people, geographically distributed, for the most part, across five different locations:¹

- Saskatoon (approx. 50%)
- Halifax and Ketch Harbour (approx. 22%)
- Montreal (approx. 14%)
- Charlottetown (approx. 9%)
- Ottawa (approx. 3%)

2.3.2 Physical Resources

Across its multiple sites, ACRD equipment and expertise has been organized into 43 research laboratories with diverse complexity, size and nature of use. These include plant growth facilities, algal growth facilities, genotyping platform, DNA sequencing systems, bioinformatics facility, nuclear magnetic resonance (NMR) and mass spectrometry, among others. The Portfolio's capital assets are currently valued at approximately \$9.6M (book value, as of October 2015).

2.3.3 Financial Resources

As the ACRD Portfolio has only existed since April 1, 2012, historic financial data before that time are not available. As well, with 2012-13 being a year of transition, financial figures for that year are not considered to be typical.

¹ ACRD also has a few remote staff and field workers located in other Canadian cities.

For 2014-15, ACRD reported total expenditures (direct and indirect) of approximately \$36.6M. Approximately 10% of these expenditures were funded through earned revenues (\$3.5M), derived mainly from technical services (54%) and strategic research (40%) (see Table 2). The balance of earned revenue came from “other revenue”, which included primarily Grants & Contributions revenue earned through the Canadian Wheat Improvement Flagship program.

Table 2: ACRD financial data (statement of operations)

	2012-13	2013-14	2014-15
Total Income	\$5.0M	\$25.2M	\$24.8M
NRC Program Investment ²		\$21.2M	\$21.3M
Earned Revenue	\$5.0M	\$4.0M	\$3.5M
<i>Technical Services</i>	\$1.6M	\$1.8M	\$1.9M
<i>Strategic Research</i>	\$3.3M	\$1.7M	\$1.4M
<i>Other Revenue</i>	\$0.002M	\$0.5M	\$0.2M
Expenditure	-\$28.0M	-\$37.9M	-\$36.6M
Indirect Expenditures	-\$12.4M	-\$13.5M	-\$14.3M
Direct Expenditures	-\$15.6M	-\$24.4M	-\$22.3M
Gains / (Losses) and other adjustments	-\$0.02M	-\$0.07M	-\$0.02M
Net gain or loss	-\$23.0M	-\$12.8M	-\$11.8M
Capital investment	-\$2.6M	-\$3.0M	-\$0.9M

Source: NRC Finance Branch (Statement of Operations)

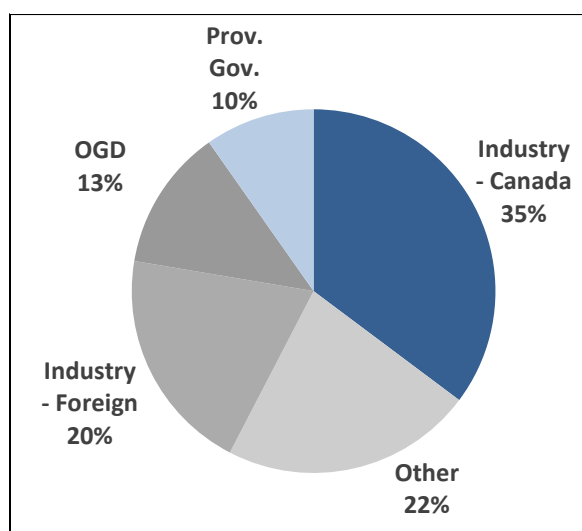
2.4 Client Profile

Over the evaluation period (2012-13 to 2014-15), ACRD has averaged 124 distinct clients per year. More than one third of revenues over this time have been generated through work with Canadian industry. This proportion has increased over the time period, going from 31% of revenues in 2012-13 to 49% of revenues in 2014-15.

Figure 1 illustrates the proportion of revenues generated, by client type, over the evaluation period. In the case of ACRD, the client type labelled as “other” includes primarily Canadian academic institutions.

Through the flagship programs, ACRD also undertakes significant strategic collaborations with partners in industry, government and academia. These collaborations generally do not take the form of revenue projects and are therefore not included in the analysis above.

Figure 1: ACRD sources of revenue (2012-13 to 2014-15)



Source: NRC Finance Branch

² NRC program investment, net loss and capital investment are fully funded by NRC.

3. RELEVANCE

The relevance of ACRD was examined from the perspectives of: the need for ACRD's R&D capabilities (section 3.1); its alignment with NRC strategic outcomes and federal priorities (section 3.2); and its alignment with federal roles and responsibilities (section 3.3).

3.1 Need for ACRD's Research and Development Capabilities

Evaluation Question 1: To what extent do the R&D capabilities offered by ACRD address a demonstrable need?

Assessment: There is a clear and demonstrable need for the R&D capabilities offered by ACRD. Through the use of these capabilities, ACRD seeks to contribute to the strength and development of the Canadian bioeconomy, which has the potential to generate significant benefits to Canada. ACRD capabilities are generally aligned with the R&D needs of industry and are focused on areas where they are likely to have an impact.

3.1.1 Role in Developing the Canadian Bio-economy

Key Finding 1: *There is a role for ACRD to play in contributing to the strength and development of the Canadian bio-economy.*

NRC has multiple independent programs and non-program activities which have substantial impacts on the Canadian bioeconomy, and ACRD resources play an important role in most of these programs and activities. Although many definitions exist to describe the bioeconomy, the Bioeconomy Interdepartmental Working Group (BIWG), which includes representatives from various Canadian federal departments and agencies including NRC, uses the following definition: “*economic activity based on the production of innovative products, including bioenergy, from biomass using novel technological processes.*”³ When considering its areas of focus, ACRD augments this definition to include applications in agriculture, food and natural health products.

Based on an analysis of both external sources and NRC internal documentation, ACRD estimates that over 900 firms operate within the Canadian bioeconomy, employing over 17,000 people and achieving over \$5B in sales.⁴ While it is possible to account for bioeconomic activity, it is important to realize that the bioeconomy is not so much an independent sector as it is a transformation of existing sectors into a more sustainable bio-enabled format. Expanding the bioeconomy has the potential to generate environmental benefits, to provide opportunities for rural development, and to open pathways for economic growth.

Other countries are now capitalizing on the bioeconomy.⁵ Despite the availability of vast biomass resources, Canada runs the risk of losing global competitiveness and remaining a low-value commodity supplier, instead of becoming the extractor of value from bioresources.

³ Carleton University, *Towards an Integrated Action Plan for the Bioeconomy*, June 2013.

⁴ This section draws heavily on an ACRD Internal working paper aimed at exploring opportunities for the development of an NRC strategy around the Canadian bioeconomy (April 2015).

⁵ Among the various research and technology organizations (RTO), A*STAR, CSIRO and VTT have developed bioeconomy strategies, while Fraunhofer has been actively involved in developing the strategy for the German Bioeconomy Cluster. Germany has been particularly successful, with bioeconomy revenues estimated at \$100B in 2010. In addition, Germany, a country which traditionally imports resources to meet its energy needs, is now exporting bio-based energy to other countries, including the U.S.

Experts consulted in relation to the BSC program specifically commented on the challenges of bringing technologies closer to market, particularly in a context where other countries are providing this type of support to their industry.

While progress in bioeconomy initiatives is being realized, there is recognition by government and industry that more could be done to capitalize on Canada's advantages and to accelerate the advancement of the bioeconomy. Senior federal government and industry stakeholders who attended a *Critical Conversation*® on the bioeconomy, hosted by Carleton University in June 2013, discussed framework conditions that would be necessary for Canada to achieve the potential benefits associated with the bioeconomy while reducing the risk of falling behind competitors.⁶ Innovation was identified as being a key ingredient in the industry's progress towards new products and new processing technologies. The development of pathways for risk-sharing on bioeconomy projects was also identified as an area for action.

It was also noted by some external interviewees, as well as two of the three experts consulted in relation to the BSC program, that NRC has a role to play in helping companies establish relationships with upstream clients and with other strategic partners and collaborators who will help them move forward along the path to commercialization. The BSC experts noted that NRC is part but not the only solution that is needed in this area and that it is not realistic to expect that NRC can provide the complete answer.

Key Finding 2: *In general, ACRD is focused on areas where it is likely to have an impact.*

The evaluation sought the opinions of experts and external stakeholders to assess whether ACRD is focused on program areas that are likely to have an impact. A summary of findings for each program area is provided below.

- **ACC:** This program is viewed by experts and external stakeholders as high risk, but with a strong potential for impacts if the program is successful. They were supportive of NRC's focus in this area and felt that it is the right approach to get value from federal research.
- **BSC:** Experts felt that the program is likely to yield strong impacts for some companies and more limited impacts for the sector as a whole. This is mainly because of the more limited NRC investment in the first three years of the program. In order to maximize impact, one expert stressed that the program needs to be selective in terms of the types of projects it accepts to ensure that the research offers significant benefits to companies and, ideally, also develops new capabilities at NRC. This expert noted that "the size of the program is not large enough to be providing services that can be accessed elsewhere." It is worth noting that the design of the BSC program is such that the initial phase (years 1-3) serves to demonstrate, through revenue generation and impacts for individual clients, that the sector is viable in Canada. According to program plans, the intent is to grow the program in the second phase (years 4-8), with increased strategic investments.
- **CWI:** Experts were not consulted in relation to this program. However, CWI external stakeholders were supportive of the need for a national wheat program and noted that the Canadian Wheat Alliance (CWA) helps to bring together the various players and funders involved in wheat breeding. They stressed the importance of wheat crops in Canada and around the world and noted that currently, wheat is only marginally

⁶ Carleton University, *Towards an Integrated Action Plan for the Bioeconomy*, June 2013.

profitable. They agreed that the CWI (NRC's contribution to the CWA) has good potential to add value and a strong likelihood of generating impacts in the form of yield and productivity improvements (especially for difficult environments). However, many stakeholders commented that these impacts will be long-term (i.e., at least a ten-year timeframe).

- **NHP:** Expert consultations were not conducted for this program. However, in the years leading up to the termination of the NHP program in the fall of 2015, it showed less potential than expected for broad sector impacts and never reached its intended scale. Although the program had a relatively large number of projects with clients located across the country, the projects the sector could undertake were smaller than originally planned within the program. In addition, the limited NRC investment in this program did not allow for larger, more strategic projects.

Moving forward, ACRD is proposing an increased focus on the food and consumer packaged goods sector.⁷ The Portfolio has articulated a strong rationale for this area of focus in recent strategic plans. This rationale revolves around the size of the industry sector (combined, the food and consumer packaged goods sectors represent the largest manufacturing sector in Canada) as well as clearly identified opportunities for impact in this sector. This area of focus was also supported by some key external interviewees and experts consulted as part of the evaluation. Specifically, a few clients and stakeholders brought up areas of need that would be worth considering as ACRD examines future opportunities in the food sector. These include:

- Increasing yields in other food crops (some external interviewees felt that the focus on wheat was too restrictive and was made at the expense of other important crops);
- Using oilseeds for protein replacement;
- Minimizing food waste (smart packaging, post-harvest preservation); and
- Improved food ingredients.

However, some stakeholders cautioned that there are many players endeavouring in this space and that it will be important for ACRD to find a specific niche area. If ACRD does pursue this as a program area, it will also be important to integrate existing relevant expertise from other NRC portfolios.

3.1.2 Alignment of ACRD Capabilities

Key Finding 3: *While the majority of ACRD's capabilities are aligned with approved programs, there are capabilities which have significant activity outside of approved programs (e.g., crop development technology platforms) and are of value to clients.*

The majority of ACRD capabilities are aligned with approved programs. However, with the recent termination of the NHP program, it was not clear how the capabilities that had previously been aligned to this program will be redeployed to other programs. Some technical services projects have been adopted by other ACRD-hosted programs and some others will continue as part of the portfolio's "Other Technical Services" stream.

As well, ACRD has significant expertise in the area of crop development technology platforms. These capabilities contribute to approved programs (e.g., CWI) but also generate a significant proportion of ACRD revenue outside of approved programs. Together, platform technologies

⁷ Despite this increased focus on the food and consumer packaged goods sector, ACRD plans to continue activities in certain carefully selected high impact initiatives in other sectors, such as the ACC program.

and other technical services accounted for 55% of ACRD earned revenue in 2014-15. Client demand suggests that there is a need for these capabilities. The development of a food program could help to better leverage these capabilities and would also allow for directed investments in this sector in order to maintain and develop these key capabilities.

Key Finding 4: *ACRD capabilities generally respond to the R&D needs of industry clients and other stakeholders.*

Experts, clients, flagship partners and external stakeholders reported that, generally, ACRD capabilities are aligned with industry needs. These needs mostly fall into two categories: 1) access to cutting edge knowledge and research, so that these ideas can be incorporated within the company; and 2) access to established technologies and technical services (genomics and bioprocessing / fermentation came up most frequently). Some concerns were raised with respect to access to cutting edge research, particularly as ACRD seeks to position itself to partner with large industry players. One key industry client commented that although ACRD capabilities are relatively comprehensive, they tend to be fairly upstream. This client felt that ACRD would benefit from a stronger commercial focus.

Some clients and stakeholders also commented that ACRD could be even more responsive if the industry community had a better knowledge of the capabilities that are available. Two clients noted that they are not clear on the full suite of NRC capabilities, outside of the work of the researcher they interact with. In two other cases, clients would have benefited from a more seamless connection to other NRC portfolios.

3.1.3 Complementarity with Other Organizations

Key Finding 5: *ACRD activities complement those offered by other organizations and facilities.*

Most external stakeholders stressed that ACRD is complementary, not duplicative, to other facilities or organizations. The majority of clients and partners interviewed could not identify other organizations or facilities that would have suitably addressed their needs. Some of the reasons given include: NRC had unique expertise or intellectual property (IP); convenience / proximity of the NRC lab; the project built on a prior relationship with NRC; and, value of the NRC reputation. In some cases, private sector or academic labs were identified as being able to meet some client needs, but were seen as being a less suitable option. Private sector labs were considered to be cost prohibitive and provided less security of information. Academic labs were characterized as being less industry focused. All BSC experts agreed that the program has either unique or complementary capabilities (bioprocessing, enzymes and fermentation, for example) when compared to those offered by other private or public sector labs in Canada.

“NRC is basically state-of-the-art in equipment for global crop science. We went there for two reasons: the facilities available and a very strong core competency of people.”

- ACRD Client

Interviewees noted that there is the potential for duplication within the CWA but that, for the most part, good communication between the CWA partners helps to ensure that the work remains complementary. That said, two stakeholders expressed the concern that with the CWI, NRC has shifted from more discovery research to applied and that this risks duplicating some of the work being done by AAFC and by the University of Saskatchewan. They also brought up the risk that, without the discovery research, sooner or later, there will be insufficient new ideas or innovations to feed into the pipeline of more applied work.

3.2 Alignment with NRC and Federal Priorities

Evaluation Question 2: Do ACRD objectives and activities align with federal priorities and NRC strategic outcomes?

Assessment: Yes. ACRD objectives and activities align with federal priorities and NRC strategic outcomes.

3.2.1 Alignment with NRC Strategic Outcomes

As per the logic model presented in **Appendix A**, ACRD strives to contribute to the achievement of a more vibrant and prosperous bioeconomy in Canada, based on a secure and sustainable biomass supply. Some of the intermediate outcomes that are intended to support this include:

- the commercialization of advanced technologies;
- increased productivity / profitability within bio-based industries, resulting from the use of technology;
- heightened level of value-added activity in Canada using Canadian biomass; and
- Canadian industry benefits from a coordinated approach to the bioeconomy.

These outcomes are well aligned with NRC's first strategic outcome, that is, "Canadian businesses prosper from innovative technologies". They also reflect NRC's focus on industry-relevant R&D, which has been identified as a priority in recent federal budgets.⁸

Given that innovative uses for biomass are being applied in a variety of areas, ACRD activities contribute to addressing at least three of the critical issues that are identified in NRC strategic documents: economic development; pressures on natural resources (in this case, related to food security, through the CWI flagship program); and, climate change and the environment (through the ACC flagship program). At a federal level, the 2014 Science and Technology Strategy also identifies Environment and Agriculture as priority areas for research.⁹

Finally, it is worth noting that, at a corporate level, mechanisms have been put in place to ensure that portfolio activities align with NRC priorities. The most significant of these mechanisms is a business planning process whereby the work of ACRD, like that of all other NRC portfolios, must fall within the scope of NRC programs. Programs are approved by NRC's Senior Executive Committee (SEC) following a rigorous stage gate process. The fact that all four ACRD-hosted programs have been approved for implementation by NRC's SEC demonstrates their alignment with NRC's strategic direction and stated goals.

3.3 Alignment with Federal Roles and Responsibilities

Evaluation Question 3: To what extent are ACRD Portfolio activities and expected outcomes consistent with federal roles and responsibilities?

Assessment: ACRD's activities and outcomes are in line with the mandate of NRC, as stated in the NRC Act. External stakeholders are also supportive of the role NRC plays conducting R&D in support of the Canadian bioeconomy.

⁸ Government of Canada, Budget 2015, p.108.

⁹ Industry Canada (2014), Seizing Canada's Moment: Moving Forward in Science, Technology and Innovation, p.20.

ACRD activities and outcomes are in line with the mandate of NRC, as stated in the NRC Act. Specifically, subsection 5 (1) (c) of the Act states that NRC may “*undertake, assist or promote scientific and industrial research*”.¹⁰ This includes research related to:

- The utilization of the natural resources of Canada
- Research aimed at promoting the expansion of existing or the development of new industries
- Research aimed at improving conditions in agriculture

Under the Act, NRC is charged with the direction or supervision of research undertaken by or for industrial firms or other organizations [subsection 5 (1) (d)] and with licensing patents related to scientific discoveries [subsection 5 (1) (l)].

External clients and stakeholders were nearly unanimous in their support for the role NRC plays, conducting R&D in support of the Canadian bioeconomy. Many stressed that this role is important for supporting economic growth and for remaining internationally competitive. A few stakeholders also noted that other similar research options available to small and medium enterprises (SMEs) are often international and prohibitively expensive for Canadian firms. Experts consulted about the BSC and ACC programs were also in agreement that NRC’s work in these areas of research is consistent with federal roles and responsibilities. In both cases, experts brought up the fact that governments in other countries are providing similar forms of support to industry.

A few interviewees recognized that there is the potential for some overlap between the mandate of ACRD and the mandate of AAFC. This could relate to activities undertaken in support of the CWA, and to other industry focused research related to food and crop development. However, stakeholders were in agreement that in practice, the activities of the two organizations have evolved to focus on different niches. In addition, good forums for communication exist between the two organizations (both within the CWA and outside) and these help to ensure that any duplication of effort is avoided.

¹⁰ National Research Council Act (R.S.C., 1985, C. N-15)

4. PERFORMANCE

The evaluation assessed ACRD's performance in terms of: its transition to a research and technology organization (RTO) portfolio (section 4.1); the appropriateness and allocation of its resources in support of NRC programs (section 4.2); progress toward the achievement of expected outcomes of both the Portfolio and its hosted programs (section 4.3); early impacts stemming from ACRD activities (section 4.4); and the efficiency of ACRD operations (section 4.5).

4.1 Transition to an RTO-Ready Portfolio

Evaluation Question 4: To what extent has ACRD been successful in its transition to an RTO-ready portfolio? What have been the factors that have facilitated or hindered this transition?

Assessment: *ACRD's transition to an RTO portfolio has taken longer than that of other NRC portfolios. Good progress has been achieved in terms of strategic focus, attention to health and safety, and increased client focus by staff. However, considerable efforts still need to be made for ACRD to more successfully operate within a matrix environment, to establish common and effective business practices, and to ensure that projects are effectively managed and delivered.*

In looking at the extent to which ACRD has been successful in its transition to an RTO-ready Portfolio, the evaluation considered the point from which the transition began as well as the factors, which have both hindered and facilitated this transition.

Facilitating factor:

- Particular individuals working at ACRD were highlighted by external interviewees as being very strong, both in terms of their technical capabilities, as well as their client focus and responsiveness. In many cases, clients and stakeholders have developed strong relationships with a particular ACRD researcher and identified this individual as the main reason why they were engaging with NRC.

Hindering factors:

- ACRD is one of the portfolios that underwent the most change as a result of the transformation. It was formed through a consolidation of components of six former institutes, which meant that ACRD first had to integrate these components before it could begin the transition to an RTO. Other portfolios, which more closely resembled prior institutes or incorporated more similar institutes, did not have this step.
- ACRD's hosted programs were established at different times, with different expectations, previously different reporting structures, and different program management models. In particular, the two flagship programs were rolled into the ACRD reporting structure in January 2015 and have different mandates with respect to revenue generation. In addition, some pillars of CWI continue to resemble the old NRC model, which has impeded progress towards an RTO and added to confusion around how the matrix model should work.

- Not having key positions staffed has impeded the Portfolio's progress. Several internal and a few external interviewees specifically mentioned the structural leadership deficiency within ACRD, including lack of local leadership in Saskatoon and the high proportion of management in acting roles. Some noted that this has led to instability and uncertainty within the portfolio. In the first years of the portfolio, some Business Management Support (BMS) positions were also not adequately staffed. The staffing of these positions was seen as being essential in moving towards an RTO model.
- The cyber-intrusion in 2014 drew attention away from other activities and also temporarily limited the availability of NRC project management training.

ACRD's success in transitioning to an RTO-ready portfolio was assessed in relation to six characteristics: strategic focus; attention to health and safety; client focus; matrix management; effective business practices; and project management.

4.1.1 Strategic Focus

Key Finding 6: *ACRD staff are focused on strategic and/or client projects.*

Staff utilization data, discussed in more detail in section 4.5, show that the majority of staff time (66% in 2014-15) is expended on approved projects. In addition, current ACRD processes ensure that approved projects are client focused and/or are of strategic importance. A few interviewees noted that funding for internal research projects decreased significantly when the Portfolio was created and that a strong strategic rationale is necessary for a project to be approved without significant client investment. The majority of internal interviewees agreed that this represents a marked difference from pre-transformation activities, when "pet projects" were much more common.

4.1.2 Attention to Health and Safety

Key Finding 7: *ACRD staff recognize that attention to health and safety is a priority and practices have significantly improved in the years since the portfolio was created.*

Internal interviewees all felt that attention to health and safety is recognized by portfolio staff as a priority for both ACRD and NRC. Some noted that when the Portfolio was established, attention to health and safety was inconsistent and there were some unacceptable health and safety practices across ACRD's various sites. However, most interviewees felt that practices have significantly improved since that time. Many commented that health and safety are ingrained in daily activities. Health and safety issues are regularly included in communications by all levels of management and safety plans are now included in project planning.

These changes in behaviour are not yet reflected in ACRD health and safety data. The number of injury and non-injury events reported in 2014-15 did not change significantly from the previous year and the number of days lost increased (this was the result of an isolated incident rather than an ongoing health and safety concern). Still, there was also an increase in the number of "near misses" reported (from one in 2013-14 to five in 2014-15). This is viewed as a positive change, as it signals that staff are now more aware, are reporting events which may not have been reported in the past, and are potentially preventing future incidents.

4.1.3 Client Focus

Key Finding 8: *The extent to which ACRD staff are client focused varies and there is recognition by the Portfolio that this is an area requiring ongoing efforts.*

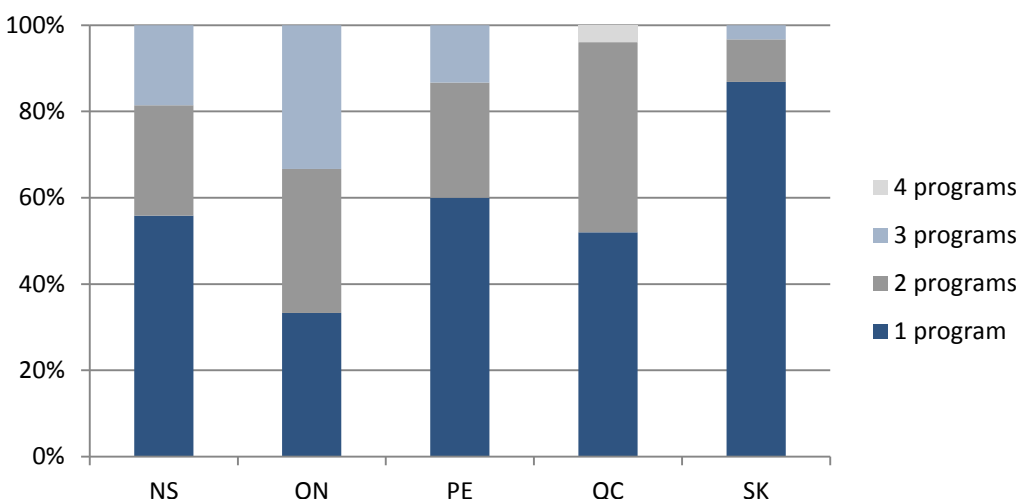
ACRD employees generally understand the importance of focusing on clients and industry-relevant projects. This is reflected in most staff behaviour, although the extent to which researchers are sensitive to client needs varies between individuals. Some internal interviewees noted that while there has been progress overall, those staff who were client focused prior to NRC's transformation continue to be those who are most client focused. Both clients and internal interviewees indicated that there is still room for improvement in terms of client responsiveness (e.g. replying to client emails in a timely manner), keeping clients top-of-mind throughout the project (e.g., being proactive in providing project updates), and delivering on client commitments. ACRD management recognizes this as an area for improvement within the Portfolio. Some client engagement training has recently been provided to ACRD staff to improve their ability to interact effectively with clients and partners, and to assist with client engagement at conferences, in meetings, and within their project roles.

4.1.4 Matrix Management

Key Finding 9: *Matrix management has enabled greater collaboration among ACRD's various sites.*

ACRD started out as an aggregation of various components of former institutes, dispersed across multiple geographic locations. Several interviewees noted that matrix management has enabled greater collaboration among ACRD's various geographic sites. However, the extent to which ACRD staff contribute to multiple programs varies between geographic locations. In Saskatoon, for example, over 85% of staff contribute to no other approved program besides the CWI flagship program (see Figure 22).

Figure 2: ACRD staff contribution to multiple ACRD programs



Source: Sigma report showing activities performed during 2015-16 (based on planned work), dated October 2015.
 Note: This figure only includes approved NRC programs hosted by ACRD (i.e., ACC, BSC, CWI and NHP).

Key Finding 10: *The roles and responsibilities of the portfolio versus those of NRC programs are not well understood within ACRD.*

Most internal interviewees felt that the extent to which matrix management is understood varies greatly across ACRD. Some commented that, even when the concept of matrix management is understood on paper, in practice, there is still confusion around the roles and responsibilities of

the programs and the portfolio. Interviewees commented that accountability for project delivery, in particular, is not always clear. This is compounded by the fact that some people have both a program and a portfolio role (e.g., Pillar Lead and Team Lead). The concept of matrix management is also more difficult to grasp in cases where resources are exclusively committed to one project for very long periods of time (as is the case for the CWI program).

Several internal interviewees commented that ACRD management does not have a uniform view of how matrix management should work within the Portfolio. Interactions and processes for the allocation of resources to projects, for example, vary between programs and depend on the individuals involved. Corporate guidance around matrix management is also quite general, with the expectation that processes will be adapted, depending on the context and needs of the portfolio.

Recommendation 1: ACRD should develop and communicate overall principles for how matrix management will work within the portfolio. This should include assigning primary roles and responsibilities and providing guidelines for program / portfolio interactions.

Moving forward, ACRD should provide regular communications relating to matrix management, encouraging sharing of best practices, and follow up regularly to assess the effectiveness of program-portfolio interactions.

4.1.5 Effective Business Practices

Key Finding 11: *Current business practices in place at ACRD are bureaucratic and overly complicated.*

Almost all internal interviewees view ACRD processes (specifically those related to project approvals and resource allocation) as being overly complicated and unnecessarily different between programs. These differences come from the fact that programs were developed at different times and, in some cases, without ACRD input early on. Within ACRD, different programs have different forms to fill, resulting in inefficiency and confusion for staff. This is further complicated for staff who work on projects led by other portfolios, as the forms and processes differ again.

Interviewees noted that, while processes differ between programs, within a program the processes and approval requirements for all projects are the same, regardless of project size. This can be frustrating for clients, who often expect a quick turnaround for small projects. This was noted as an issue by some clients who commented that the time to get a quote or contract in place used to take a few days and can now take several weeks. These clients frequently attributed the delay to higher levels of approval outside of the geographic region. ACRD's current project agreement development process for external projects has been mapped in a flowchart which includes a minimum of eight process and decision steps in the initiation phase, in addition to a minimum of 10 process and decision steps in the project planning phase. As noted above, this is the process for all projects, regardless of size. Interviewees commented that there are likely opportunities to simplify the process, especially for lower risk projects.

ACRD management is aware of these issues and efforts are currently underway to harmonize (where appropriate) and simplify processes across ACRD's hosted programs. A few internal interviewees noted areas where practices have been improved (e.g., IP negotiation for BSC projects) and could be shared more broadly across ACRD or NRC once they are further refined.

Recommendation 2: ACRD should continue current efforts to review processes surrounding the approval of projects and allocation of resources, with an aim of harmonizing (where appropriate) and simplifying them. As part of these efforts, ACRD should adapt the level of approvals required, depending on risk, project size and maturity of program.

Following this review, simplified processes should be effectively implemented and validated.

4.1.6 Project Management

Key Finding 12: *Most ACRD staff understand the value of project management and recognize that it is a required practice at NRC. However, many lack the skills and access to the resources that would allow them to manage projects effectively.*

Project management is inconsistent across ACRD, both in terms of how it is done and how effectively it is done. As of the third quarter of 2015-16, ACRD had booked the necessary revenue in order to meet its targets for the year. However, some interviewees voiced concerns about ACRD's ability to *earn* this revenue in the current fiscal year, due to difficulties delivering the contracted projects on time and on budget. A few internal interviewees also noted that although some projects are being tracked, project management information is not generally being used to actively direct project delivery (e.g., prioritizing resources). When asked, the Portfolio was unable to easily provide data as to the proportion of projects completed on time or on budget, further illustrating that additional efforts are required to improve project monitoring at a Portfolio, or program, level.

The 2015-16 ACRD Operating Plan highlighted the harmonization of ACRD's project and program management models as a priority for the year, as there were different practices in place for each of its hosted programs. To accomplish this, ACRD launched a Project Management Integration group with four priority areas. This initiative, which took approximately one year, was recognized as an important effort across the Portfolio. However, many internal interviewees felt that the study and analysis period was too lengthy and that early outputs from this study would have been beneficial over the year (e.g., training opportunities, some tools). The evaluation's findings pertaining to each of the four Project Management Initiative's areas are discussed below. As the integration group has not yet finalised their work, the evaluation will not comment on the results of the group's efforts, but rather provides the information below for their consideration.

- **Awareness:** This has been addressed in large part. The majority of internal interviewees (which included all ACRD team leads) understand that project management is a required component of their work and want to improve their project management abilities.
- **Technologies and tools:** This was raised by some internal interviewees as being a barrier to the effective management of projects, as well as a barrier to effective resource management. In some cases, the issue was the absence of tools, while in other cases, interviewees brought up the lack of support to be able to use the tools which are available corporately (e.g., support staff to generate project system reports) or a lack of awareness of the tools available and how they should be used. Beyond tools to manage the delivery of individual projects, there is also a need for resource management tools to support team leads in better managing their teams (e.g., to have a more holistic view of staff commitments).

- **Knowledge:** The majority of internal interviewees raised project management training as a necessary step before other project management efforts can be effective. Many internal interviewees felt that staff would benefit from additional training (particularly for current project leads and team leads). Some also pointed out that mentoring, coaching and other forms of support from the ACRD Project Management Office (PMO) would be beneficial.

In 2015-16, 60 individuals within ACRD were responsible for leading projects, of which 47% had received project or program management training. When considering only those individuals who led projects with a collective value of over \$50,000, the proportion of those who have received training increases to 55% (22 of 40 individuals). It is worth noting that training offered through Planning and Reporting Services (PRS) had been temporarily put on hold following the 2014 cyber-intrusion, although it has since been restored. ACRD management in Montreal was able to organize separate project management training during this time through an external service provider.

- **Roles and Responsibilities:** Currently, the role of ACRD project managers (i.e. those within the ACRD PMO) focuses on supporting programs, as opposed to supporting individual projects. This differs from many other PMOs across NRC. Interviewees had different opinions as to whether researchers or dedicated project managers should be managing projects, although many agreed that the ideal model could depend on the size and scope of the project, as well as on the project management abilities of the lead researcher. Many interviewees also agreed that, no matter the model chosen, ACRD needs to ensure stronger accountability for the timely delivery of projects.

Recommendation 3: Project Leads, Team Leads and other appropriate staff should be sent on project management training as soon as it is available. If it is not expected to be available through NRC in a timely manner, outside sources of training should be considered.

The role of the centralized PMO should be re-evaluated; roles may differ based on project size and project management skills of the Project Lead. ACRD should also consider whether there is a role for dedicated or more experienced project managers to provide coaching and support to new project managers.

4.2 Appropriateness and Allocation of ACRD Resources

Evaluation Question 5: *Are ACRD resources appropriate, and are they allocated effectively to deliver on program outcomes?*

Assessment: *For the most part, ACRD has the appropriate technical competencies and equipment in place to meet current program needs, although high variability in resource demand and utilization is an indication that resources could be managed more effectively. Further capacity development by underutilized staff, in particular, could also help ACRD minimize risks related to limited depth of expertise in specific areas. Interviewees also noted the importance of continued strategic investments in ACRD competencies to ensure that these remain leading edge and are able to meet future program and client needs.*

Key Finding 13: *For the most part, ACRD has the appropriate technical / scientific competencies and equipment in place to meet current program needs.*

In accordance with the NRC operating model, ACRD operates as a matrix-based organization with the portfolio owning and managing all human and capital resources and facilities, while programs control R&D operating funds (as approved by NRC's Senior Executive Committee). The portfolio allocates its human resources to meet program needs, and facilitates program access to facilities.

For the most part, ACRD has the appropriate technical / scientific competencies and equipment in place to meet current program needs.¹¹ The two flagship programs appear to be particularly well resourced, as described in the table below.

Table 3: Availability and appropriateness of resources to support the CWI and ACC flagship programs

CWI	• CWA partners felt that NRC is contributing appropriately to the CWA (significant investment relative to other partners). • All partners commented on the high quality of research and scientific calibre of ACRD staff involved in the Alliance. They noted that NRC's main scientific contributions to the CWA are in genomics / genotyping and bio-informatics. • Some identified gaps include: ○ Need for expansion of the plant growth facility in Saskatoon – According to ACRD's 2015-16 Operating Plan, planning for this work is almost complete. ○ Need for additional bio-informatics capacity (equipment and staff) – A bioinformatics investment plan has been approved and the implementation of the plan was to be coordinated with Shared Services Canada. However, the 2014 cyber intrusion halted this work and it is unclear how the plan will be implemented in the future. If delays persist, there is a risk that this could affect NRC's credibility and reputation in this area.
ACC	• The scientific excellence of the research team supporting the ACC program was confirmed by international experts and through a bibliometric study (top research facility in this area in Canada and "one of the leading groups on the world stage"). • ACC partners and international experts felt that NRC's level of investment is appropriate and reasonable. Experts praised NRC's focus (as compared to other countries that spread funding "a mile wide and an inch deep").

The BSC program was approved for implementation in early 2015-16, and there is a necessary ramp up period before all resources are in place to meet program needs. That said, human resource (HR) and infrastructure plans are in place to address these needs. In the interim, third party suppliers have been contracted in some cases to help ensure that resources are available. Table 4, on the following page, presents an assessment of the availability and appropriateness of ACRD resources to support this program.

¹¹ Since the NHP program was terminated over the course of this evaluation, an assessment of the availability and appropriateness of ACRD resources to support this program is not included.

Table 4: Availability and appropriateness of resources to support the BSC program

BSC	• Two of the three BSC experts noted the small size of NRC's investment considering the national reach of this program. • HR and infrastructure plans are in place to address program needs. • There were delays in filling some of the program's key leadership roles, although this has now been resolved. • Capacity development has been built into the program; some staff will need to be redirected in order to better meet program needs. • Inability to hire before securing contracts is a constraint for the program.
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As noted above, NRC operates in a matrix environment and ACRD resources are also drawn upon to support NRC programs hosted by other portfolios. Since the Industrial Biomaterials Flagship Program (IBFP), which is hosted by NRC's Automotive and Surface Transportation Portfolio) was intended to draw significantly upon ACRD resources, the availability and appropriateness of resources to support this program was also assessed as part of the evaluation. This is discussed in the table below.

Table 5: Availability and appropriateness of resources to support the IBFP program

IBFP	• In the original business plan for the IBFP, approximately 40% of the program's 90 planned full-time equivalents (FTEs) were intended to come from ACRD. • In reality, the program operates on a much smaller scale than had been planned. The program uses a total of approximately 20 FTEs per year, of which 2.5 are from ACRD (one is a full-time project manager for the program). • Although the program has been able to access some technical resources, the expectation was that the IBFP would also have access to technical leaders with client engagement skills, who could identify opportunities with industry and convert these into revenue projects. This never materialized – existing technical leaders were assigned to other programs and no additional resources were hired. • It is worth noting that the IBFP reported having difficulty engaging resources from other portfolios as well (not just ACRD).
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Key Finding 14: *There may be additional opportunities for underutilized staff to contribute to increased capacity in critical areas of expertise.*

The demand and utilization of resources by programs is very uneven across ACRD's five geographic sites. At some sites, utilization for 2014-15 was 30% or less (this is further detailed in section 4.5.1., Efficiency Indicators). At the same time, internal interviewees raised concerns regarding the depth of expertise available in specific areas. This presents risks in terms of succession planning, heavy workload on a limited number of staff, and the Portfolio's ability to meet client demand. A couple of internal interviewees commented that, although there is excess capacity available within the portfolio, it is not always the right capacity to meet program needs.

Over the past year, ACRD has made efforts to re-allocate and/or retrain staff, where this was feasible. However, given ongoing concerns, there may be additional opportunities for under-utilized staff at some ACRD sites to participate in cross-training or job shadowing in order to increase bench strength in critical areas of expertise.

Key Finding 15: *There is a risk that NRC staff will not remain leading edge and will not have new, innovative service offerings for clients in future years.*

Some internal interviewees raised concerns about the fact that the portfolio appears to be mostly responsive when it comes to competency development. Internal capacity building projects are limited to those that are undertaken (and funded) through approved programs. There is a risk that NRC staff will not remain leading edge and will not have new, innovative service offerings for clients in future years. One external stakeholder also raised concerns over access to cutting edge research. This stakeholder commented that “NRC is positioning itself to partner with the large players, but then you have to offer them something that they don’t have”.

ACRD management recognizes the need to be strategic and proactive, in order to develop new capabilities in directions of future growth. These will lead to the next generation of products and programs to meet client needs. The GM Standing Committee of ACRD revenue, strategy and R&D, which is made up of all ACRD directors and program leads, was created in early 2015 and provides the vehicle for these discussions. However, this committee has so far been fully committed with other initiatives and priorities. Some Team Leads also felt that they could play a more strategic role in identifying areas within their team where competencies could be developed or deepened to support future program areas.

4.3 Progress toward the Achievement of Expected Outcomes

Evaluation Question 6: *Are ACRD and its hosted programs on track to achieve expected outcomes?*

Assessment: *Yes, ACRD and its hosted programs are on track to achieve expected outcomes, although there were a few opportunities identified to increase the likelihood of achieving all desired outcomes.*

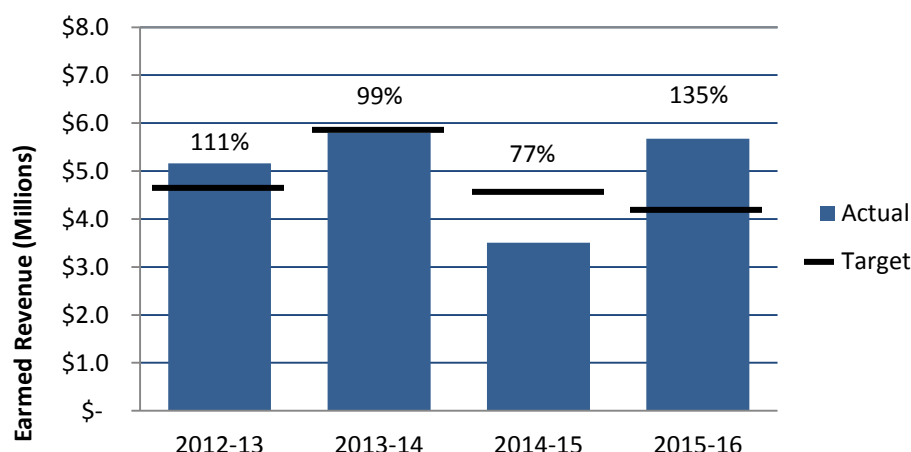
ACRD’s ultimate expected outcome, as described in the logic model (Appendix B) is to contribute to a more vibrant and prosperous bioeconomy in Canada. ACRD’s hosted programs are designed to contribute to this ultimate outcome, and each has its own set of expected outcomes. Progress towards these outcomes can be assessed, in part, by examining the extent to which performance targets and program milestones have been met. The evaluation also sought the opinions of experts and external stakeholders on the likelihood that expected program outcomes would be achieved. Client outreach and engagement, as well as client satisfaction, are also seen as key factors that will contribute to ACRD’s likelihood of achieving its expected outcomes, and are therefore also discussed in the sections below.

4.3.1 Achievement of performance targets and program milestones

Key Finding 16: *Following lower than expected revenues in 2014-15, ACRD has exceeded its revenue target for 2015-16.*

A key performance metric for ACRD, like all NRC portfolios, is the extent to which the portfolio has met its targets for revenue generation. While ACRD met its revenue targets in its first two years of operation, revenues decreased in 2014-15 and ACRD achieved only 77% of its revenue target that year (see Figure 3). Preliminary financial figures for 2015-16 (as of April 15 2016) indicate that ACRD exceeded its 2015-16 revenue target of \$4.2M by 35%, having achieved \$5.7M in revenues for the year.

Figure 3: Percentage of ACRD revenue targets met



Source: NRC Finance Branch. 2015-16 actuals reflect preliminary year-end financial figures, as of April 15, 2016.

As most of the remaining expected outcomes for ACRD reflect those of its hosted programs, each program is discussed separately below.

4.3.1.1 Canadian Wheat Improvement Flagship Program

Key Finding 17: *All of the evidence gathered through the evaluation supports the CWI's progress towards achieving its expected outcomes, while cautioning that it is still early into a long-term program.*

CWI program progress reports confirm that the program has met the majority of its performance targets to date and is on track to achieve key deliverables, planned for the end of 2016-17. Based on preliminary financial figures as of April 15, 2016, the CWI earned \$1.0M in revenue in 2015-16, more than doubling its revenue target of \$450K for the year. External stakeholders also agreed that CWI progress to date, as a component of the broader Canadian Wheat Alliance (CWA), has met their expectations, specifically in terms of stronger interactions between the partners and some scientific progress being made. However, interviewees stressed that the CWA is a long term initiative and that it is still “early days”. The CWA was the subject of a mid-term review in 2015, which drew similar conclusions:

- *The impact of the CWA is difficult to assess after only 3 years of operation. Most of the work described in the six pillars will take a significant period of time to manifest itself in improved varieties or industry know-how and products [...] the work started in 2012 has recorded, for the most part, excellent progress towards the established milestones. Thus it was felt that the work was on track to achieve the milestone objectives.*¹²

Both the mid-term review and all relevant interviewees raised concerns about the governance of the CWA. Many stakeholders viewed the CWA as being too NRC-centric, the perception being that it is driven by NRC, as opposed to being a true alliance. As a result of the mid-term review, adjustments to the structure of the CWA, including pillar leadership, are currently being examined. External stakeholders were more positive about the CWA management and steering committees, stating that these committees represent all of the organizations involved, foster good communication among the partners, and are efficient. Some stakeholders also commented that NRC plays an important leadership and coordination role within the CWA.

¹² Canadian Wheat Alliance Mid-Term Impact Review, p. 3.

4.3.1.2 Algal Carbon Conversion Flagship Program

Key Finding 18: *While plans for the ACC program have changed from the initial design, the current approach is considered to be strong and viable and the program is progressing well against the new plans.*

The original plan for the ACC flagship program included, as a key milestone, the engineering, construction and operation of a 100,000 litre ACC Demonstration Facility at a bitumen extraction facility in the Alberta oil sands by fiscal year 2014-15. These efforts were put on hold in January 2014 due to concerns regarding construction costs and energy requirements that arose during engineering. The program has since shifted plans from its original deployment strategy. In September 2015, NRC's Senior Executive Committee approved a new two-phased approach for the program. The revised plan includes a first deployment at a cement plant in Ontario (scheduled for 2016-17), and a second deployment at a Canada's Oil Sands Innovation Alliance (COSIA) sponsored R&D facility in Alberta (scheduled for 2018-19). This approach will allow the research team to validate and fine-tune the technology in a cost-effective, step-wise fashion for two industries (cement manufacturing and bitumen production). A new contract with ACC industry partners was executed in October 2015.

All of the ACC industry partners interviewed as part of the evaluation reported that ACRD staff were very responsive throughout the project adjustment process and all are satisfied with the revised plan. All partners also reported that, since the revised plan was approved, ACC has had significant momentum and is progressing quickly against it, while still maintaining the necessary scientific rigour. The first demonstration plant in Ontario will become operational, as per the new plan, in April 2016.

International experts consulted as part of the evaluation all felt that NRC has developed a solid and viable approach with the ACC program. With respect to expected outcomes, all experts consulted agreed ACC is well positioned and highly likely to be successful in confirming the technical feasibility of a 25,000 liter demonstration facility operating on the stack gas of a cement plant by 2018 (expected outcome 1). However, they all also raised concerns with regards to ACC's ability to demonstrate the economic viability and environmental sustainability of an algal bio-refinery operating at commercial scale by 2020 (expected outcome 2), given what they perceived to be the absence of a robust and detailed techno-economic assessment (TEA) model. In actual fact, the program has indicated that ACC industry partners have completed TEA models, tailored to their internal business cases, but these models are proprietary to the partners and were not available for distribution to the expert reviewers. In addition, the ACC program will be developing a robust and meaningful TEA, based on empirical data, costs and parameters measured through the delivery and operation of the ACC demonstration plant. Two experts qualified the timeline of 2020 for the second expected outcome as being very aggressive, albeit achievable.

"The use of a photobioreactor system is innovative and certainly mitigates the issue of Canada's geography and climate [in the production of algae]. If the ACC program experience is successful, this could offer huge opportunities."

- International expert

4.3.1.3 Bio-based Specialty Chemicals Program

Key Finding 19: *Early program milestones for the BSC program have been met and experts felt that the program design is likely to lead to the achievement of expected program outcomes.*

The BSC program is just completing its first year of activity but progress reports indicate that the program is generally on track. It has performed well against its initial program plans and has met many of its initial performance targets (e.g., related to program launch). Preliminary end-of-year financial results show that the program achieved \$2,009,893 in revenue in 2015-16, exceeding its target by 17%. The program also booked approximately \$3.5M in revenues overall, creating a pipeline of work for 2016-17.

The three experts consulted in relation to the BSC program were of the view that over a 5 to 10 year timeframe, the program is likely to achieve all or some of its expected outcomes. Two experts noted that the program timeline is relatively aggressive, given the complexity of this technology and the industry context. Experts raised some factors that may influence the achievement of expected outcomes, including: firms' ability to pay for NRC services and the availability of venture capital investment in Canada; the need for careful selection of partners and projects; the IP landscape and international competition in this area; the culture at NRC and the ability of its scientists to work on commercialization; and, the inherent technical challenges. Table 6 presents the experts' views in terms of the likelihood of achieving BSC's four expected outcomes.

Table 6: Expert views on the likelihood of achieving BSC expected outcomes (5-10 year timeframe)

1. Commercialization of near-term industry technologies	Likely
- Experts felt that the program is likely to contribute to this expected outcome, but that it will take at least five years (if not eight or ten) to see commercialization results. - One expert commented that some of the later steps toward commercialization are beyond the control of the program and companies would likely require support from other strategic partners along the way.	
2. Increased investment in Canadian technologies by multinational enterprises (MNEs)	Somewhat likely
- Experts had mixed views. Two experts agreed that the BSC program might contribute to attracting foreign investors, as it could help to raise awareness about the sector in Canada. Access to NRC and its programs was also seen as potentially being of value to investors. - The third expert was more skeptical that BSC would generate interest by MNEs, given the small size of the program and what he perceived to be a focus on early stage technologies.¹³	
3. Increased productivity / profitability within Canadian bio-based industries resulting from the use of technology	Likely
- All three experts agreed that BSC's activities were likely to contribute to this expected outcome, over a 10-year timeframe. Still, they felt that BSC was likely to achieve considerable impacts for some companies, and more limited impacts on the sector overall, given the moderate program investment. - Two experts noted that in order for Canadian companies in this area to be viable in the long term, they must target international markets.	

¹³ According to BSC Program representatives, the Program does not focus on early stage technologies, but rather seeks to advance industrial technologies from a technology readiness level (TRL) of between 3 and 5 to a TRL of 7 or more.

4. Heightened level of value-added activity in Canada using Canadian biomass	Likely
• The experts agreed that there are many opportunities for Canada around biomass valorization and that NRC can play a role, since it is among the few organizations in Canada that have the required expertise in this area. • Success for some clients and partners is likely to attract others to the program.	

4.3.1.4 Natural Health Products

Key Finding 20: *Given the limited receptor capacity of Canadian firms operating in the area of natural health products, the NHP program had a limited potential to generate impacts.*

The NHP program met some of its technical and progress milestones for 2014-15, although several were delayed to the following year. While NHP completed the planned number of projects in 2014-15, they were smaller than initially intended and, as a result, generated less revenue for the program (46% of target). As of November 2015, NHP had 50 active projects, of which 35 were valued at less than \$10,000 and only two projects were valued over \$50,000.¹⁴ This had been a constant challenge for the NHP program since its inception, although it should be noted that many NHP clients were repeat customers, often having multiple concurrent projects. A few interviewees commented that there is insufficient receptor capacity to support the NHP program, as many of its clients were small and unable to afford the cost of NHP services, in the absence of external funding support.

Further aggravating the issue, a few clients and stakeholders pointed to a recent change in interpretation of policies defining how Atlantic Canada Opportunities Agency (ACOA) funding could be spent. The result of this is that funding from the Atlantic Innovation Fund (AIF) can no longer be spent on NRC services. This issue affected the NHP program more than others, given the existence of a significant bioscience cluster in Prince Edward Island (PEI). A little over half of NHP's revenues between 2012-13 and 2014-15 came from companies located in Atlantic Canada and a little over 20% came from PEI specifically. Two clients said that the change to AIF funding was likely to affect the extent to which they worked with ACRD in the future. Other stakeholders noted that this would have a negative impact on both ACRD's ability to generate revenue as well as local SMEs' ability to access high quality research and technical services.

During the course of the evaluation, NRC made the decision to terminate the NHP program. It is expected that most technical services projects will be adopted by other NRC programs and others will continue as part of the portfolio's "Other Technical Services" stream.

4.3.2 Outreach and Awareness

Key Finding 21: *The Portfolio has conducted effective outreach efforts and increased awareness of the Portfolio; however, some specific improvements are identified for future outreach efforts.*

In the past year, ACRD has been active in networking and outreach activities. External stakeholders felt that the Portfolio, particularly through its Program Leads, Portfolio Business Advisor (PBA) and Client Relationship Leaders (CRLs), has been visible in the community and is participating in the right events. Some of ACRD's Program Leads, as well as the PBA and

¹⁴ From ACRD updated revenue target figures, dated November 2015.

CRLs, have made conscious efforts to engage with Industrial Research Assistance Program (IRAP) Industrial Technology Advisors working in sectors relevant to their program.

Efforts were generally seen to be effective. ACRD has been successful in working with new clients¹⁵ each year, adding over 40 new clients in each of the past two years. However, several external interviewees felt that ACRD should make additional efforts to promote the specific services available, as well as the benefits of working with NRC. A few stakeholders commented that firms who had worked with NRC in the past generally had a moderate understanding of what was available at ACRD; however, firms who did not have a previous relationship with ACRD did not know what could be available to them. The lack of detailed and client-focused information on the NRC website about ACRD, its available services, and available licensing opportunities was highlighted as a missed opportunity for the Portfolio.

Some current clients and stakeholders felt that there had not been sufficient external communication from ACRD or NRC about NRC's transformation to an RTO. They remain unsure of NRC's long term strategy and desired end state. One company representative expressed concerns about the continued availability of NRC services, commenting that the lack of communication makes it difficult for the company to depend on NRC for future research activities.

Client engagement was highlighted as a priority for ACRD in its 2015-16 Operating Plan, and ACRD has since launched a client outreach and engagement initiative. While internal staff agreed that there is a need for efforts in this area, some raised concerns about the length of time the initiative has taken and the lack of results / action to date. Some staff felt that it would have been more appropriate for this initiative to be led by BMS instead of by ACRD.

Several internal staff had concerns about the roles of ACRD and BMS staff concerning client engagement and account management, as their respective roles are not well defined and are inconsistent between programs. Concerns were raised about the efficacy of researchers playing significant business development roles instead of delivering on opportunities generated by CRLs. This is particularly true since, as of mid-2015, the Portfolio was supported by a full complement of CRLs. In addition, ACRD had booked its targeted revenue by October 2015, the earliest it has been booked since ACRD was established in 2012.

Recommendation 4: In collaboration with BMS, ACRD should clarify and communicate how the two can work effectively together to achieve client outreach and engagement objectives. BMS support and mentorship should also be provided to researchers who are interested and effective in engaging with industry, to enable them do so. Finally, ACRD should clarify which client engagement roles are most effectively done by BMS staff (e.g., cold calling new clients and qualifying opportunities) and which are done most effectively by researchers (e.g., clear understanding of clients' needs, timely development of proposals, meeting client expectations by completing work on time and on budget).

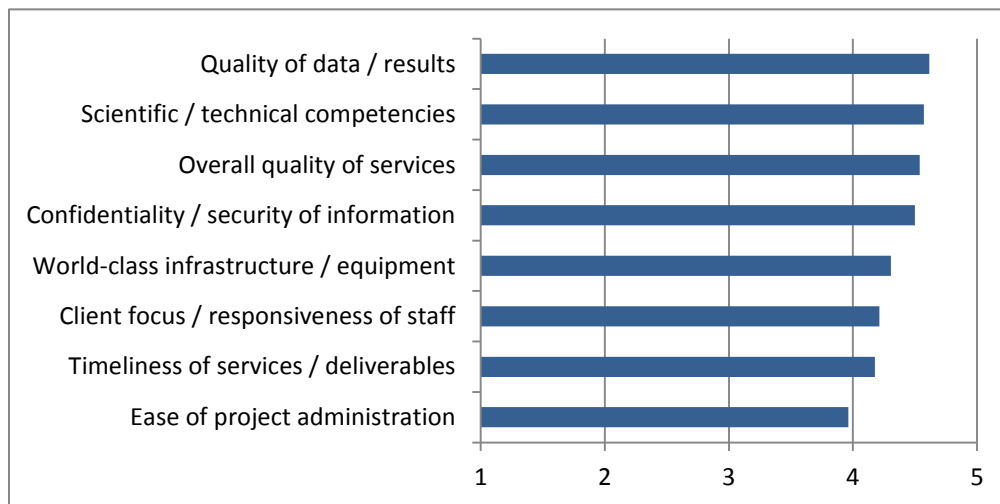
4.3.3 Client Satisfaction

Key Finding 22: *The majority of clients are very satisfied with the services they have accessed from ACRD.*

¹⁵ New clients are defined as those who did not have a previous contract with ACRD, meaning it includes those with prior institute relationships, as well as those with relationships with other parts of NRC.

When asked to rate their level of satisfaction with ACRD, the majority of respondents (clients and partners) were extremely positive about the overall quality of services they received (most rated this as 5 out of 5). They highlighted the quality of work, professionalism and expertise of staff as being areas of strength for ACRD. Client criticisms primarily centered on the administrative aspects of the interaction (e.g., length of time for quotes and contracts), although some tempered this by saying that, while NRC processes could be improved, they are still more efficient and less bureaucratic than those of other governmental and quasi-governmental agencies they have engaged with. Further, they noted that ACRD staff (both research and contracting) made efforts to reduce the burden and make the process as straightforward for them as possible.

Figure 4: Average satisfaction rating of ACRD clients (out of 5)



External interviewees felt that the quality of ACRD work is at least as good, and often better, than that produced by other research institutions they know of or have worked with in the past. Costs were also seen as comparable and, in the few cases where they felt ACRD was more expensive, most clients felt the quality of work produced merited the added cost (if this was not true, these clients would have sought the services elsewhere).

When asked about the benefits of working with ACRD beyond the aspects noted above, clients and partners highlighted NRC's industry focus, co-investment opportunities, and the breadth of expertise available across NRC that ACRD can tap into as being the most significant for them. In terms of the disadvantages that were raised, one is specific to ACRD (i.e., the lack of local decision-making authority in Saskatoon) whereas the majority are broader issues that affect NRC overall (i.e., the handling of the cyber-intrusion, excessive bureaucracy).

4.4 Early Impacts

Evaluation Question 7: Is there evidence of early impacts resulting from the activities of ACRD and its hosted programs (building on the activities of ACRD predecessor institutes)?

Assessment: Yes, clients and partners identified early impacts attributable to ACRD, such as the advancement of technology readiness, accelerated path to market, and increased company spending on R&D.

Given the relatively recent creation of the Portfolio and its hosted programs, and the fact that many of ACRD's activities are intended to have longer term impacts, the evaluation focused on any early impacts that have been experienced by clients, and expert views as to the likelihood of programs achieving longer term impacts, based on program design and progress to date.

Key Finding 23: *Clients identified mostly early impacts achieved as a result of their projects with ACRD.*

Most clients and collaborators felt that their projects with ACRD have been successful in achieving the project's desired outcomes and many referred to ACRD's contribution as both outstanding and crucial to the project. In several cases, the clients felt that ACRD researchers were now the "subject matter experts" in the client's technology and reported that they were interested in continuing the relationship through subsequent project phases, or by asking NRC researchers to play an advisory or trouble-shooting role once the formal project had concluded.

Many clients reported that it was still too early to have achieved socio-economic impacts as a result of their NRC project. In cases where clients were able to identify impacts, these were mostly early or immediate impacts, as is expected at this stage of program maturity. The impacts most frequently identified by clients as a result of their project or relationship with ACRD were: advancement of technology readiness (8 of 12 clients), accelerated path to market (7 of 12) and increased company spending on R&D (6 of 12). Several clients also noted that NRC's credibility and reputation have had a positive impact on their business. They noted that the involvement of NRC lent credibility to the work produced, was a positive factor for public relations, and/or helped to attract other potential collaborators and outside investment to the company or project. Two strong examples of impact are described below.

- **Dycor Technologies:** This Canadian technology firm has had a series of ACRD projects, which used metagenomics to identify and categorize bacteria found in oil wells, in order to improve the efficiency of oil recovery. Following the pilot of the technology solution, the amount of recoverable oil produced in the test well increased by 20% (from 5 barrels per day to 6 barrels per day) and the amount of highly saline production water produced by the well (which must be carefully handled and treated by the oil company) was reduced by nearly 50% – a direct, positive impact on operational expenditures. The projects have led to increased profitability for Dycor, as this technology solution became a key factor in the establishment of Dycor's new Petroleum Microbiology business line (representing up to one-third of the company's annual revenues). The work also led to positive financial and environmental impacts for Dycor's client, a large oil and gas company.
- **Nature's Crops International (NCI):** NCI is a Canadian firm that manufactures specialty, plant-derived oils which are used as ingredients for dietary supplements, food, and cosmetics. Over the past five years, ACRD has provided technical services to NCI, as the company sought the necessary regulatory approvals to be able to commercialize Ahiflower® oil, a new Omega-3 oil, in the United States (US) and Europe. According to a company representative, ACRD's involvement in the development of analytical methodology was critical to the process, as NRC's reputation and credibility were key factors that led to acceptance of NCI's novel oilseed product by regulatory authorities. Ahiflower oil is currently on the market in both the US and Europe, and NCI is now working on additional commercialization opportunities in other markets. As stated by the company representative, "without the piece provided by NRC, product commercialization would certainly have been delayed".

Key Finding 24: *Clients and partners reported that these impacts could not have been achieved to the same extent in the absence of the Portfolio.*

Clients who identified impacts stemming from their work with ACRD were also asked to comment on the extent to which they attribute these impacts to the Portfolio's contribution. Overall, ACRD's contribution to the achievement of these impacts was rated as being moderate to high. Some clients and collaborators saw NRC's contribution as essential to their project. This was most often due to a unique combination of expertise and/or IP available at ACRD or to NRC's reputation and credibility (as was the case for Nature's Crop International, in the example above). In some other cases, while the project could have progressed without ACRD, it would have been more difficult, taken longer and/or been more expensive. For technical services projects (e.g., sequencing), clients frequently had other options available but noted benefits to accessing the services through ACRD (e.g., geography, existing relationship, level of expertise). In these cases, any identified impacts stemming from these projects likely would have occurred in the absence of ACRD.

For both of the ACRD-hosted flagship programs (ACC and CWI), NRC's involvement in these projects was seen by external stakeholders as essential to their success. The research team supporting ACC was highlighted as having expertise that is unique in Canada and being uniquely positioned to bring together the project collaborators. Partners agreed that the ACC demonstration project would not have been undertaken without NRC's involvement. NRC's involvement was also seen as critical in establishing the Canadian Wheat Alliance, although it is important to recognize that significant research efforts were already being undertaken by other CWA partners. These partners stressed that NRC's expertise and funding augmented what was already in place and has the potential to accelerate the achievement of outcomes.

4.5 Operational Efficiency

Evaluation Question 8: *How efficient are portfolio operations? What factors are affecting the operational efficiency of the portfolio?*

Assessment: *The efficiency of ACRD operations could be improved. This is due, in part, to factors that are internal to ACRD (e.g., client focus of staff and ineffective business practices). However, other factors that are affecting the operational efficiency of the portfolio include reduced support from NRC corporate branches and increasing non-project activities, both of which limit the available time researchers and technical staff have to undertake project work.*

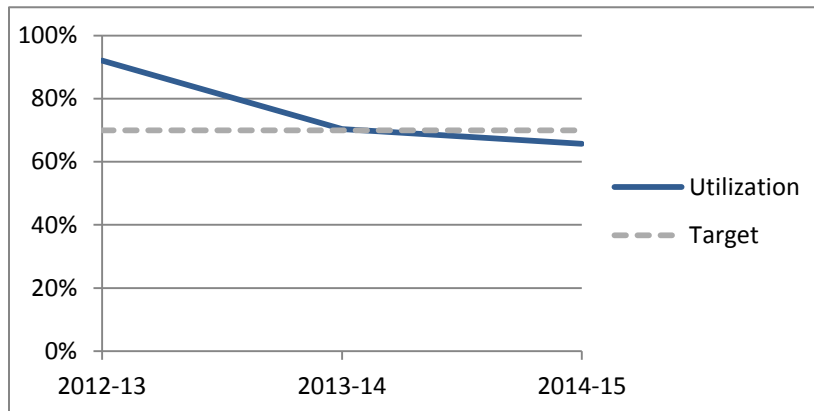
4.5.1 Efficiency Indicators

Key Finding 25: *Corporate key performance indicators show a decline in portfolio efficiency in recent years.*

Corporate data indicate that ACRD's overhead efficiency decreased in 2014-15 from previous years. The overhead efficiency indicator calculates indirect costs (that is, any costs that are not directly charged against a project) as a percentage of total expenditures. For 2014-15, ACRD's indirect expenditures represented 39% of total expenditures. This was up slightly from the year before (indirect expenditures represented 35% of total expenditures in 2013-14) and exceeded the budgeted rate of 28%.

Staff utilization also decreased over the past three years (see Figure 5). In 2014-15, 66% of ACRD's labour expenses were recovered by NRC programs. Again, this fell short of ACRD's target rate for the year (70%).

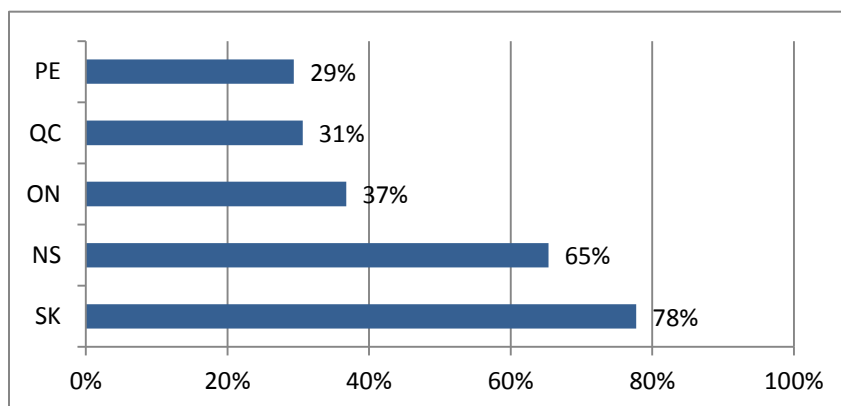
Figure 5: ACRD staff utilization



As with other aspects of the portfolio's performance, staff utilization rates vary greatly between sites (see Figure 6). Some internal interviewees commented on factors that have affected staff utilization. For some sites (e.g., Charlottetown, Montreal, and Ottawa), interviewees felt that low utilization was largely due to the smaller amount of client work available (lack of demand for services), particularly prior to the launch of the BSC program. The fact that the BSC program had not yet been approved contributed to lower utilization numbers in 2014-15 for two reasons: 1) BSC-related projects were not yet being actively pursued; and 2) time spent by ACRD staff working toward the approval of the program is not considered to be a direct program cost and therefore does not contribute to higher utilization rates.

For other sites (e.g., Halifax), interviewees reported that lower utilization was due to an increasing amount of non-project activities that are required of research staff. These include many essential activities (e.g., safety, security, HR management), as well as many activities, which had previously been supported to a larger extent by common services. All of these activities reduce the time available for projects. In fact, some interviewees were surprised that ACRD was even able to reach over 65% utilization, given the other commitments that are seen to be cutting into available project time.

Figure 6: Utilization of ACRD staff, by region



Note: PE=Prince Edward Island; QC=Quebec; ON=Ontario; NS=Nova Scotia; SK=Saskatchewan.

ACRD's facility utilization rate for 2014-15 was 50.2%, which slightly surpassed its target for the year (49%). A trend over time could not be calculated, as historical facility utilization data is not available.

4.5.1 Efficiency of Service Delivery to Clients

Key Finding 26: *Internal efficiency issues have affected client services.*

Internal inefficiency has also had an impact on ACRD's external relations. Clients were generally quite positive about the service they received from ACRD, although the two aspects where they were most critical were "timeliness of services and deliverables" and "ease of project administration". With respect to the "timeliness of services and deliverables", 4 of the 14 clients interviewed rated this element as 3 out of 5 or lower. This issue is related to client focus and was further discussed in section 4.1.3. Three (3) of the 14 clients interviewed also rated the second element, "ease of project administration", as a 3 out of 5 or lower. When probed for details, clients spoke specifically about slow contracting, lack of flexibility in the contract structure (i.e., need to take into account business practices) and cumbersome / opaque project administration. This issue was discussed in more detail, and a recommendation is proposed to address the issue, in section 4.1.5 (Effective Business Practices).

4.5.2 NRC Common Services

Key Finding 27: *ACRD has had significant service issues with some NRC common services. These have contributed to inefficiencies and have had a negative impact on portfolio operations.*

Internal interviewees raised significant concerns related to interactions with various common services across NRC. ACRD has multiple sites across the country and interacts with close to 90 common service liaisons across these sites. The level of service offered by NRC common services varies considerably from site to site and appears to be dependent on the customer service inclination and willingness of particular individuals. While some individuals were highlighted by ACRD staff as being particularly helpful, this was attributed to the nature of that specific individual and not the overall approach of the branch.

In cases of centralized services, interactions generally ranged from mediocre to very negative. Interviewees noted an overwhelming feeling that researchers and common services providers are "not all pulling in the same direction" and that while research portfolios are encouraged to be client-focused, they do not feel that the common services that support them have that same mentality. In cases where interviewees were less critical of the services received, many still commented that services that had previously been provided by dedicated staff (i.e., communications, human resources and business development personnel that were integrated within former institutes) have been downloaded to research staff in recent years.

"You can't be a top RTO with this kind of service."

- Internal interviewee

- **Administrative Services and Property Management (ASPM):** Although interviewees raised concerns about all common services to some extent, ASPM was clearly the greatest source of frustrations. ASPM was highlighted by almost all internal interviewees as being unresponsive, and not client-focused; one interviewee referred to the relationship between ASPM and ACRD as being "adversarial". This was one of the strongest examples where there is an apparent lack of accountability and no recourse available to the Portfolio for poor service. ASPM management recognizes some of these gaps and is working to address them. Dedicated building operation leads have been, or

are in the process of being, assigned in Halifax, Montreal and Saskatoon. This is expected to take pressure off the existing regional leads, who had both responsibilities in the past. It is also worth noting that over the past year some steps have been taken to address these issues, including ongoing discussions between ACRD and ASPM management, ASPM communications to regional employees reinforcing the importance of client-focused service delivery, and a joint ASPM-ACRD planning session to develop a site maintenance plan for the Ketch Harbour location.

- **Information Technology and Security Services (ITSS) / Shared Services Canada (SSC):** Many interviewees viewed ITSS / SSC services as being inefficient and slow, although there were instances of good customer service by ITSS personnel at some sites. As ACRD has many geographic sites outside Ottawa, the portfolio is greatly affected by frequent service disruptions in the regions. Many interviewees noted that approved IT infrastructure purchases requiring SSC support have not been made (e.g., bioinformatics) and that, being external to NRC, SSC is, in some cases, “oblivious” or “agnostic” toward the needs of the organization.
- **Business Management Support (BMS):** Specific individuals currently supporting the Portfolio were highlighted as being responsive and client-focused. Still, interviewees commented that the effectiveness of BMS is very dependent on the individuals in place. Many interviewees felt that BMS should be providing more of a “sales” function, and there is the feeling that downloading of sales and business development to researchers is not efficient. This is discussed in more detail in section 4.1.3 (Client Focus) and a recommendation is proposed.
- **Human Resources Branch (HRB):** Specific individuals supporting the Portfolio were highlighted as being responsive and client-focused. However, many internal interviewees commented that the centralization of HR services appears to have led to a decrease in the services provided by HRB. They noted several services which are no longer provided by HRB (e.g., onboarding, training support) and others which are less accessible in locations where there is no Human Resource Generalist on site. Centralized staffing was not highlighted as being particularly problematic, although interviewees did note that hiring processes continue to be slow.
- **Finance Branch (FB):** Again, interviewees felt that ACRD has very good individual support from FB. However, some interviewees highlighted FB processes, forms and centralized support (e.g., travel) as being inefficient.
- **Planning and Reporting Services (PRS):** Comments on PRS were mixed, as interviewees discussed different aspects of PRS’s delivery, some positive and others negative. Several interviewees described PRS as “confusing”. These interviewees felt that PRS adds excessive process and duplicates existing reporting requirements, as opposed to providing support to program and project delivery. Some of the more positive aspects discussed by interviewees include the training offered and the communities of practice that have been established by PRS.
- **Communications Branch (CB):** Interviewees commented that the move towards centralized services has led to slightly reduced communications support but that the quality of the services provided is more consistent across the organization. Some commented that CB has successfully produced marketing materials and success stories for the portfolio, but that these products have also required considerably more portfolio

staff time now that CB staff are less integrated with the portfolio (and therefore less knowledgeable about portfolio programs and activities).

- **Knowledge Management (KM):** Interviewees had mixed views about interactions with KM. Several interviewees described very positive interactions and noted that KM had been responsive in providing requested information and keeping them informed of recent developments within their subject area. In contrast to most other NRC common services, most interviewees noted that KM is very helpful and responsive. Those who were most critical felt that KM provides many reports but could be adding more value through analysis or synthesis. Some interviewees also felt that KM's contribution may be limited due to a lack of awareness across the organization as to what services are available.

Recommendation 5: NRC Senior Management should ensure that all corporate / common services have appropriate service standards in place, as well as a mechanism to escalate cases where client service and responsiveness are inadequate.

5. CONCLUSION

Repeatedly throughout the evaluation, ACRD was described as being a microcosm of NRC. In fact, many of the issues ACRD is facing are issues that have also been raised in other portfolio evaluations or through NRC communities of practice. However, these pain points are perhaps experienced more intensely at ACRD, given its history, structure and geography. The recommendations made throughout this report focus on improving the internal operations of the Portfolio and its interactions with NRC corporate services in order to optimize portfolio efficiency and enable ACRD to perform to its highest potential. As many of the challenges faced by ACRD are not unique to this portfolio, there is an opportunity for some of the solutions developed at ACRD to be shared across the organization.

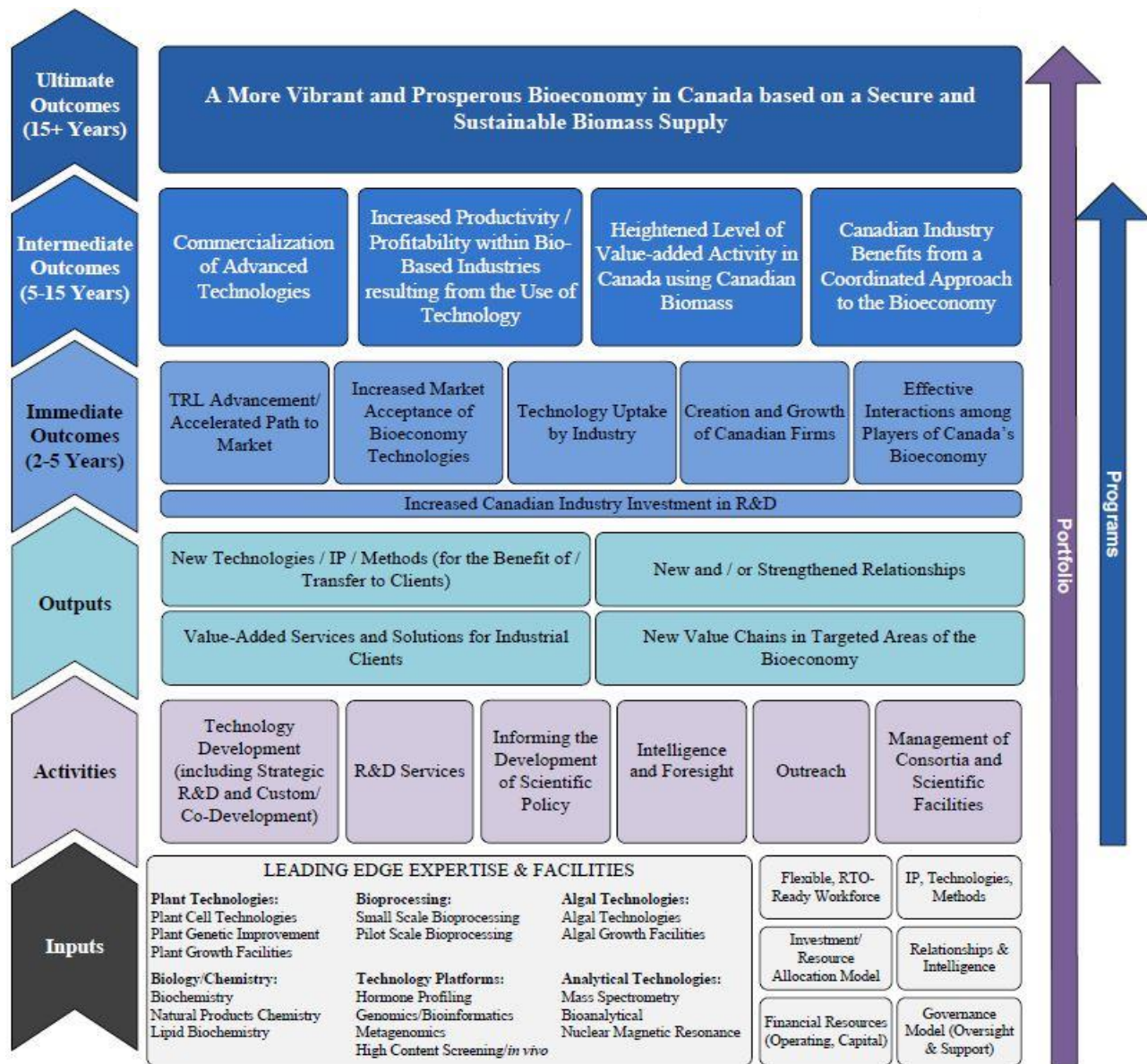
6. MANAGEMENT RESPONSE

Recommendation	Response and Planned Action(s)	Proposed Person(s) Responsible	Timelines	Measure(s) of Achievement
1. Matrix management ACRD should develop and communicate overall principles for how matrix management will work within the portfolio. This should include assigning primary roles and responsibilities and providing guidelines for program / portfolio interactions. Moving forward, ACRD should provide regular communications relating to matrix management, encouraging sharing of best practices, and follow up regularly to assess the effectiveness of program-portfolio interactions.	Recommendation accepted. ACRD is adopting a balanced program-portfolio matrix model. ACRD will deliver a document to staff, clearly defining program-portfolio interactions and outlining key program and portfolio roles and responsibilities. Training will follow and mentoring will be provided via the PMO. ACRD will enhance communication to all staff via Portfolio-wide Town Halls and Program team-Team Lead meetings, where we will communicate best practices. ACRD will conduct quarterly reviews of programs to ensure effective program delivery. ACRD will continue its monthly pipeline review meetings, as well as biweekly meetings between Program Leads (program-based) and ACRD management (portfolio-based).	ACRD GM ACRD GM, Directors, Program Leads and Team Leads ACRD GM via the GM Standing Committee ACRD GM	End of Q1 of FY 2017 Ongoing; beginning in Q1 of FY 2017 Ongoing; first review: end of Q2 of FY 2017 End of Q1 of FY 2017	Document delivered and discussed broadly across ACRD; Monthly updates to all staff via Town Halls and consistent Team Lead-Program team interactions; Documented reviews; best practices shared and implemented across the Portfolio; Key actions incorporated in the FY2017 Operational Plan;

Recommendation	Response and Planned Action(s)	Proposed Person(s) Responsible	Timelines	Measure(s) of Achievement
2. Common and effective business practices ACRD should continue current efforts to review processes surrounding the approval of projects and allocation of resources, with an aim of harmonizing (where appropriate) and simplifying them. As part of these efforts, ACRD should adapt the level of approvals required, depending on risk, project size and maturity of program. Following this review, simplified processes should be effectively implemented and validated.	Recommendation accepted. A preliminary review and recommendations on Project Agreement Development (including project selection and resource allocation) and associated project management processes were presented and approved by ACRD Management in late FY 2016. A Project Management Working Group under ACRD's PMO will complete and roll-out the processes, including approval and resource allocation, over the full project management life cycle for both internal and external projects. BMS and the ACRD PMO are working to further simplify and streamline processes for low value, low risk projects. An analysis to support this review has been completed. ACRD harmonization efforts will be aligned with NRC-wide initiatives, where applicable.	ACRD GM Team Lead of ACRD PMO, Team Lead of Portfolio and Program Development BMS PBA and Team Lead of the ACRD PMO ACRD GM	End of Q1 of FY 2017 End of Q2 of FY 2017 Ongoing End of Q1 of FY 2017	Documented processes and flow charts are prepared, circulated and communicated across the Portfolio. Harmonization of PM processes has been implemented across all programs hosted by ACRD. Ongoing review and feedback mechanism for validating processes will be documented. Participation in and alignment of NRC-wide harmonization efforts will be ongoing. Key actions incorporated in the FY 2017 Operational Plan.

Recommendation	Response and Planned Action(s)	Proposed Person(s) Responsible	Timelines	Measure(s) of Achievement
	Response from VP, Human Resources Branch (HRB): HRB will establish and share service standards in the areas of occupational safety and health, hiring, classification and client services. As part of the service standards, escalation mechanisms will be articulated. Response from VP, Business and Professional Services (BPS): A draft Service Level Agreement (SLA) has been developed, which includes service standards for each BPS Branch and outlines the annual review process and the dispute resolution process. The VP BPS will review the SLA with R&D VPs to ensure that there is mutual agreement on services and standards.	Isabelle Gingras, VP Pam Bjornson, A/VP, BPS	July 30, 2016 July 31, 2016	Service standards in place and shared with clients Escalation mechanisms outlined and shared with clients SLA signed by service providers and clients

APPENDIX A: ACRD LOGIC MODEL



APPENDIX B: METHODOLOGY

The evaluation of ACRD was led by an independent evaluation team from the NRC Office of Audit and Evaluation (OAE). This appendix presents the detailed evaluation methodology used by the evaluation team and includes a discussion on the evaluation design, methods, and the challenges and limitations encountered.

Evaluation Design

The questions to be addressed through the evaluation were developed following consultations with portfolio management and the Vice-President, Life Sciences, who identified specific areas of interest and information needs. These were incorporated into the evaluation design, which also meets the requirements of the Treasury Board Policy on Evaluation.

Table 7: Evaluation questions

<i>1. To what extent do the R&D capabilities offered by ACRD address a demonstrable need?</i>
<i>2. Do ACRD objectives and activities align with federal priorities and NRC strategic outcomes?</i>
<i>3. To what extent are ACRD Portfolio activities and expected outcomes consistent with federal roles and responsibilities?</i>
<i>4. To what extent has ACRD been successful in its transition to an RTO-ready portfolio? What have been the factors that have facilitated or hindered this transition?</i>
<i>5. Are ACRD resources appropriate, and are they allocated effectively to deliver on program outcomes?</i>
<i>6. Are ACRD and its hosted programs on track to achieve expected outcomes?</i>
<i>7. Is there evidence of early impacts resulting from the activities of ACRD and its hosted programs (building on the activities of ACRD predecessor institutes)?</i>
<i>8. How efficient are portfolio operations? What factors are affecting the operational efficiency of the portfolio?</i>

The evaluation of ACRD placed a significant focus on internal and/or operational issues facing the portfolio. This decision was made for multiple reasons. Firstly, ACRD is one of the portfolios that underwent the most change as a result of the transformation in 2012. It experienced further organizational changes in January 2015 when two flagship programs were rolled into the ACRD reporting structure. As well, many of ACRD's programs and activities were only launched in 2012 (or after). It was therefore too early to expect to see longer-term impacts resulting from these activities.

Evaluation Methods

The approach used for the evaluation was commensurate with the level of program risk, which was assessed as low / medium during an assessment conducted as part of the planning phase. Methods were also selected in light of other relevant studies or reviews being undertaken by the program.

To maximize the possibility of generating useful, valid and relevant evaluation findings, a mixed methods approach was used. The mixed methods approach incorporates qualitative and quantitative data gathered using several lines of evidence. This approach is well-suited for providing end-users with a nuanced understanding of complex evaluation issues. In addition, it significantly increases confidence in evaluation conclusions and recommendations when the same findings are obtained through multiple lines of evidence, while also facilitating deeper examination in instances where findings diverge. The methods used as part of this study included:

- Internal and external document review;
- Administrative and performance data review;
- Semi-structured interviews; and
- Expert consultations pertaining to two of ACRD's hosted programs.

A discussion of the approach used for each of these methods is provided in the following paragraphs.

Internal and External Document Review

Internal and external documents were reviewed, synthesized and integrated into the evaluation to provide context and history, and to complement other lines of evidence in assessing relevance and performance. Internal documents reviewed included strategic, business, and operational plans for the portfolio and the four programs, performance reports, reviews, presentations, intranet articles, and any other document identified by portfolio management and staff. In addition, a wide range of external documentation and literature was also reviewed by the evaluation team. A selected list of documents reviewed can be found in Appendix C.

Administrative and Performance Data Review

Administrative and performance data for 2012-13 through 2015-16 were reviewed to provide information on resourcing, program outputs and activity levels, financial performance, and operational efficiency. These data contributed to the analysis of program need, achievement of expected outcomes, and resource utilization. To the extent possible, administrative data was drawn from corporate systems and from corporately prepared reports (e.g. reports prepared by Finance Branch and Planning and Reporting Services).

Semi-Structured Interviews

Semi-structured interviews were conducted with portfolio stakeholders to collect information such as personal experiences, opinions, and expert knowledge. This information was used to complement other lines of evidence and to contextualize quantitative information.

In total, 49 interviews were conducted, including 25 with internal NRC staff and 24 with external ACRD stakeholders. The breakdown by interviewee type is provided in Table 8. The evaluation

deliberately included a high proportion of internal interviews, so as to include a wide range of perspectives (from team level to management) on a variety of internal issues. External interviewees included clients from across ACRD's hosted programs, as well as clients of the crop development platform technologies, which represent a large proportion of ACRD's revenue. Client organizations interviewed through the evaluation represented 34% of ACRD's revenue over the evaluation period. Other external stakeholders interviewed included ACRD's partners in the ACC flagship program, the CWA, and other large initiatives, as well as Canadian industry stakeholders (e.g., industry associations). The selection of interviewees reflects the information needs of the evaluation and was informed through the document review, by suggestions made by ACRD management during the evaluation planning phase, and by other interviewees.

Table 8: Stakeholders interviewed

Interviewee Category	Interviewee Type	Number of Interviews Conducted
Internal	ACRD management	7
	ACRD staff	9
	Other NRC representatives (including Senior Executives, BMS, IRAP)	9
External	ACRD clients (current and in negotiation)	12
	ACRD collaborators and partners	9
	Other Canadian industry stakeholders	3
TOTAL		49

Interviews with internal stakeholders were conducted mostly in person, while interviews with external stakeholders were primarily conducted by telephone. Interview guides were developed to align questions with the information requirements as identified in the evaluation framework and were provided to interviewees in advance of the discussion. This process ensured that the information requested would yield relevant information in support of evaluation judgement criteria and indicators. The majority of interviews were individual; however group interviews were conducted with Team Leads, for efficiency and to provide a richer discussion.

Expert Consultation

Individual consultations (one-on-one interviews) with six experts were conducted in order to assess the relevance and performance of two of ACRD's hosted programs. These included three international experts who commented on the ACC flagship program and three Canadian experts who commented on the BSC program. The experts were selected in consultation with ACRD management and staff. Two of the three recruited experts for the BSC program were affiliated with private sector firms and the third was affiliated with a university. All three ACC experts were either associated with universities or with government research institutes.

Expert consultations were not conducted for the CWI flagship program given and for the NHP Program. For CWI, industry experts had been consulted as part of a recent mid-term review of the Canadian Wheat Alliance (CWA), so the evaluation drew upon that study instead of repeating efforts. Expert consultations were initially planned for NHP. However, these were cancelled when the NHP program was terminated mid-way through the evaluation study.

The consultation process proceeded as follows:

- Preparation of the program profiles and other review material by ACRD and Knowledge Management staff;¹⁶
- Review of program profiles and other relevant material by the experts;
- Delivery of a presentation to experts by the ACRD program leads to describe the program's approach and progress to date, as well as answer questions; and
- Conduct of semi-structured interviews with experts, during which the experts were asked to comment on the relevance of the program, on the quality and appropriateness of the program approach, and on ACRD competencies, in the context of achieving program outcomes.

The responses provided by the experts were analyzed and findings were generated at the program level. These findings were triangulated with the findings from other lines of evidence to strengthen the analysis and interpretation of results.

Challenges and Limitations

Various limitations and challenges were experienced in conducting the evaluation of ACRD that need to be taken into consideration when interpreting the findings. Several of the challenges and limitations in the current evaluation are not unique. Rather, they are common in most evaluations conducted within the federal government. In order to alleviate the effects of the limitations and challenges on the evaluation findings, various mitigation strategies have been used. The main challenges experienced by the evaluation team as part of the project include the following:

- **Interviews as a primary line of evidence and potential response bias of client and internal interviewees:** Client and collaborator interviewees were limited to those who could be contacted, using the most up-to-date contact information obtained from the Portfolio and who agreed to be interviewed. This could bias interviewees towards those who have a more positive view of the program, and therefore a greater vested interest in the results of the evaluation. As a mitigation strategy, clients were contacted at least twice. Those who were hesitant to participate were provided with thorough information about the evaluation, its importance (and the value of their participation in ensuring valid results) and about the confidentiality of responses. In the end, clients interviewed as part of the evaluation represented organizations that were the source of 34% of ACRD's revenue over the past two years. Further, all flagship partner organizations contributed to the evaluation. While internal interviewees could be motivated to conceal less positive aspects of ACRD's performance, ACRD management encouraged staff to be open and transparent about the issues they experienced.
- **Recent changes to ACRD and its hosted programs:** In the last year, ACRD gained two flagship programs (ACC and CWI in January 2015), had a new program approved (BSC in April 2015) and terminated its original program (NHP, in the Fall of 2015). In order to ensure that the evaluation provided the most useful information possible, current events and data have been incorporated throughout the evaluation process, including during the preparation of the report.
- **Other reviews of ACRD's hosted programs:** As discussed, the CWA recently conducted a mid-term review which assessed much of NRC's CWI activities. In addition,

¹⁶ In addition to the material prepared by ACRD, NRC's Knowledge Management (KM) Branch prepared a bibliometric study on algal carbon conversion, which was also provided to the ACC experts. This bibliometric study served to characterize and assess the scientific impact and credibility of ACC's publications.

ACRD's hosted programs will also be subject to NRC mid-term reviews after three years of operation. To limit interviewee fatigue, external interviewees who were consulted as part of the CWA mid-term review were excluded to the extent possible. In cases where their contributions were essential to the evaluation, the other review was recognized and questions focused on areas which were not included in the review. The other review was also drawn upon as much as possible to reduce duplicating effort. To ensure this evaluation would add value and not duplicate what was expected from the NRC mid-term (three-year) review, the evaluation was designed to focus on areas which were not typically covered in these reviews, but were still of significant interest to ACRD and NRC senior management.

APPENDIX C: SELECTION OF DOCUMENTS REVIEWED

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